

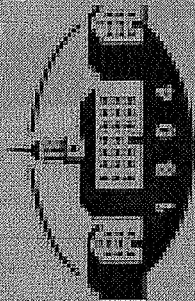
Abstract

NASA Technologies for Product Identification

by

**Fred Schramm
NASA Marshall Space Flight Center
Engineering Directorate**

Since 1975 bar codes on products at the retail counter have been accepted as the standard for entering product identity for price determination. Since the beginning of the 21st century, the Data Matrix symbol has become accepted as the bar code format that is marked directly on a part, assembly or product that is durable enough to identify that item for its lifetime. NASA began the studies for direct part marking Data Matrix symbols on parts during the Return to Flight activities after the Challenger Accident. Over the 20 year period that has elapsed since Challenger, a mountain of studies, analyses and focused problem solutions developed by and for NASA have brought about world changing results. NASA Technical Standard 6002 and NASA Handbook 6003 for Direct Part Marking Data Matrix Symbols on Aerospace Parts have formed the basis for most other standards on part marking internationally. NASA and its commercial partners have developed numerous products and methods that addressed the difficulties of collecting part identification in aerospace operations. These products enabled the marking of Data Matrix symbols in virtually every situation and the reading of symbols at great distances, severe angles, under paint and in the dark without a light. Even unmarkable delicate parts now have a process to apply a chemical mixture called Nanocodes™ that can be converted to a Data Matrix. The accompanying intellectual property is protected by 10 patents, several of which are licensed. Direct marking Data Matrix on NASA parts virtually eliminates data entry errors and the number of parts that go through their life cycle unmarked, two major threats to sound configuration management and flight safety. NASA is said to only have people and stuff with information connecting them. Data Matrix is one of the most significant improvements since Challenger to the safety and reliability of that connection. This presentation highlights the accomplishments of NASA in its efforts to develop technologies for automatic identification, its efforts to implement them and its vision on their role in space.



OHIO
UNIVERSITY

2006

AUTOMATIC IDENTIFICATION & DATA CAPTURE
TECHNICAL INSTITUTE

NASA Technologies for Product Identification



Fred Schramm

Engineering Directorate

NASA Marshall Space Flight
Center

July 28, 2006

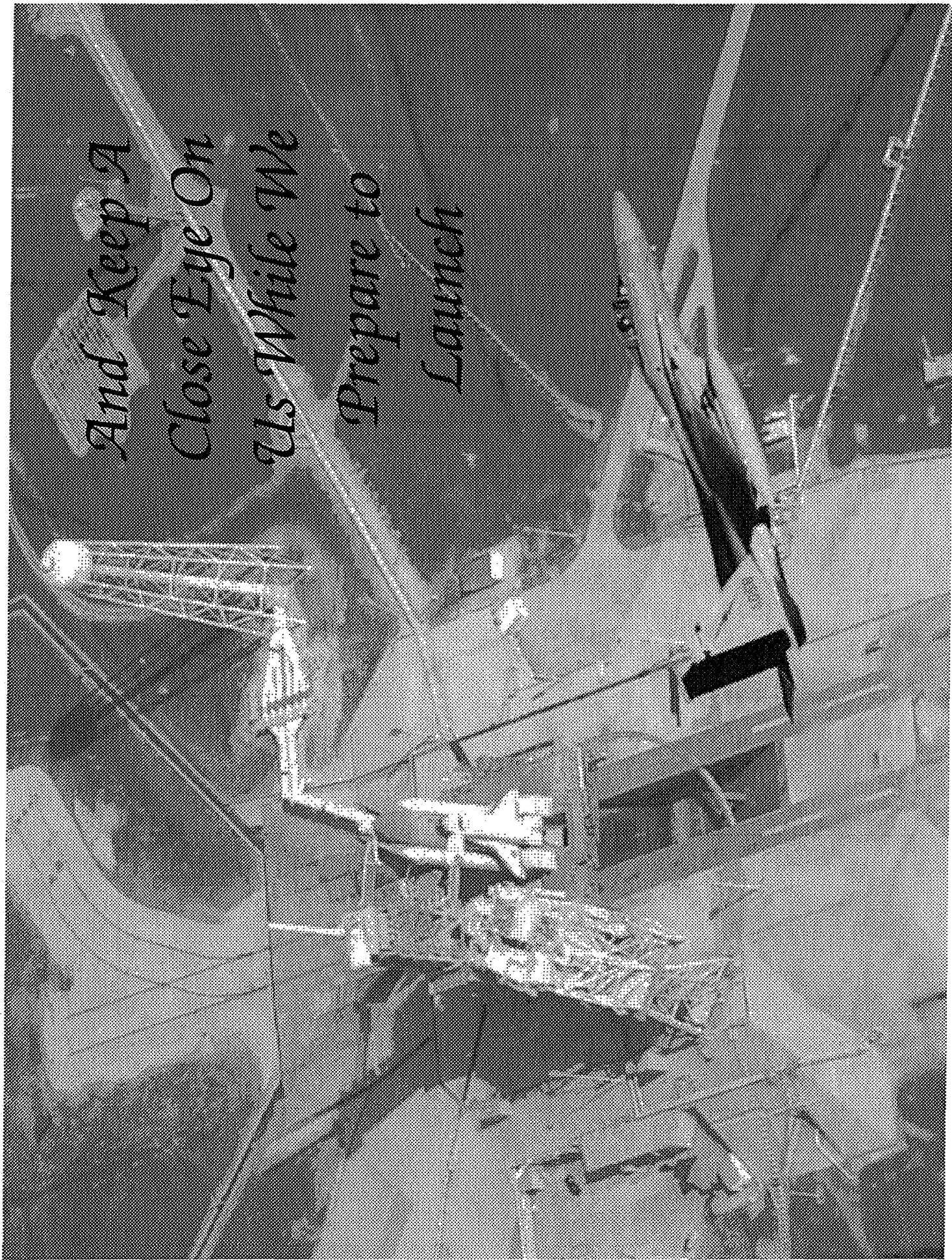
A black and white photograph of the American flag, showing the stars and stripes. The flag is slightly tilted and has a soft, draped appearance.

NASA Thanks Those Who

Protect Our Freedom

Global, Homeland, Hometown

*And Keep A
Close Eye On
Us While We
Prepare to
Launch*

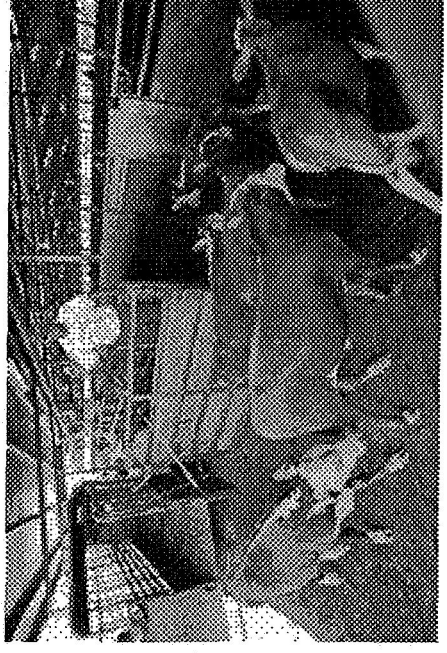


Today's World....More Things Being Tracked... Even the Food Supply

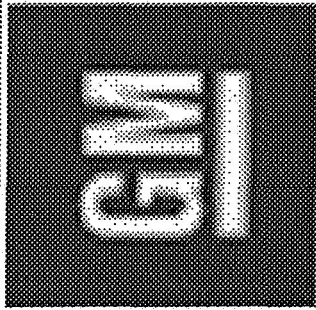


United States Department of Agriculture

NEW NATIONAL ANIMAL ID SYSTEM WILL GUARD AGAINST MAD COW DISEASE AND ANIMAL HEALTH PROBLEMS

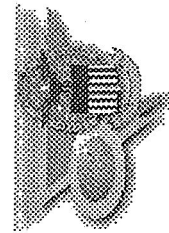


Different Organizations Track Parts for Different Reasons

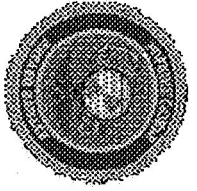
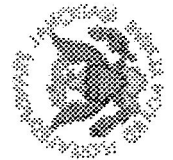


*Configuration
Management*

TREAD ACT



Readiness



UID



TREAD Act:
Early Warning
Reporting

The Perfect Storm

November 1, 2000

*Transportation Recall Enhancement, Accountability,
and Documentation Act (TREAD Act)*

Ford Aware of Venezuela Tire Defect in 1998

■ **Safety:** The auto maker and Bridgestone Firestone also are under siege from the Florida attorney general.

From Times Wire and Staff Reports

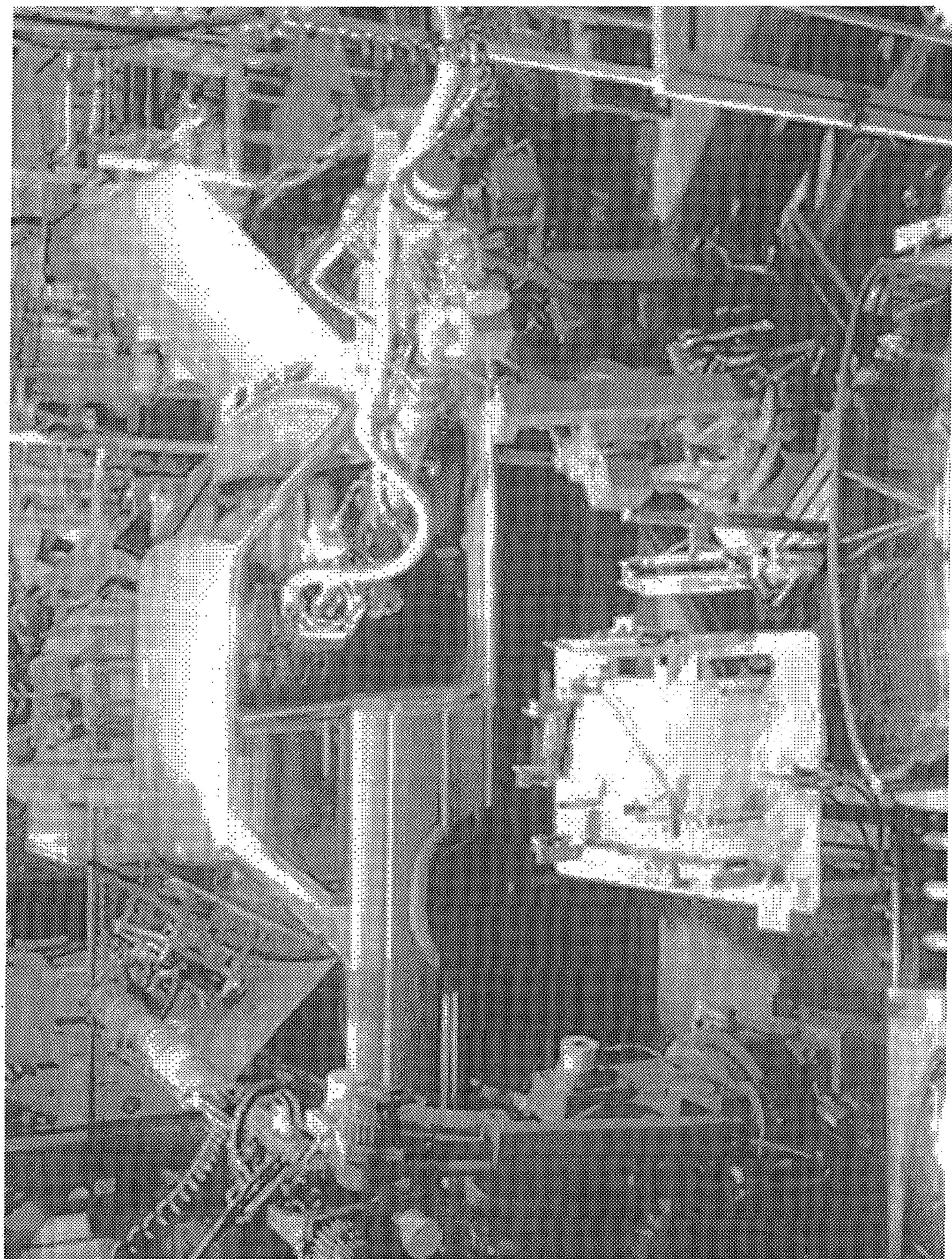
CARACAS, Venezuela—Ford Motor Co. said Tuesday that its first report of problems with Firestone tires on Explorer sport-utility vehicles in Venezuela came in 1998—two years before it began replacing

Ford Had Data On Tire Safety, Records Show

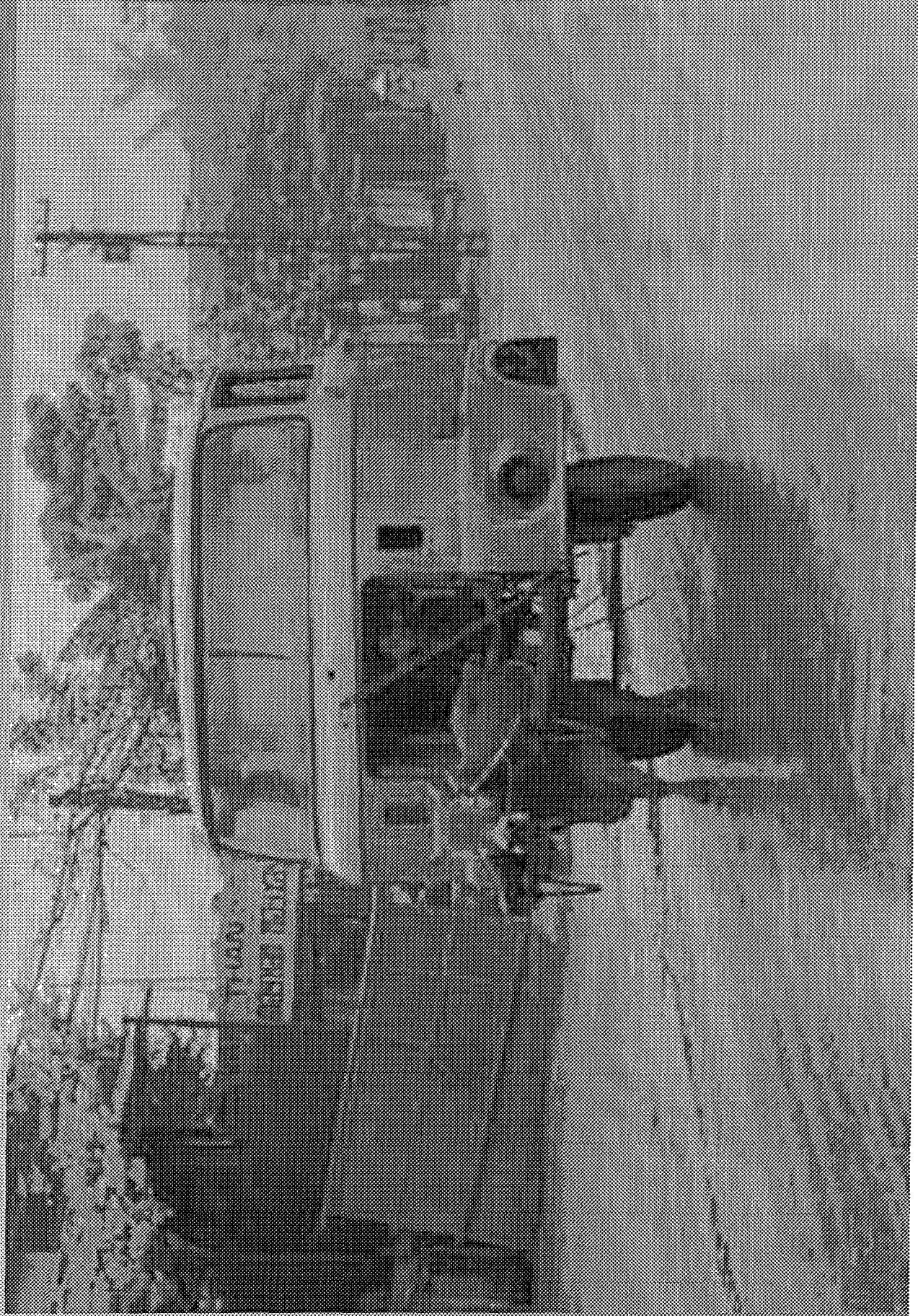
By Barbara Pomeroy

and Kenneth R. Warren
and Kenneth R. Warren
said Tuesday that its first report of problems with Firestone tires on Explorer sport-utility vehicles in Venezuela came in 1998—two years before it began replacing

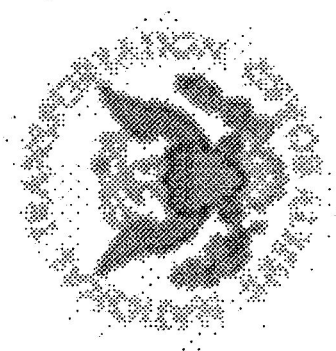
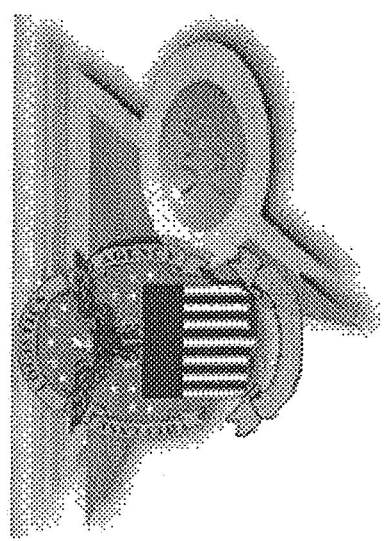
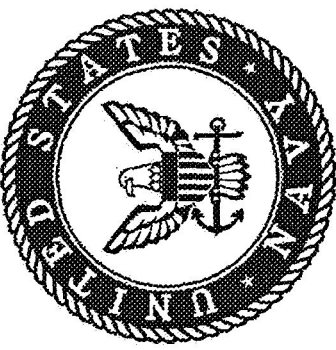
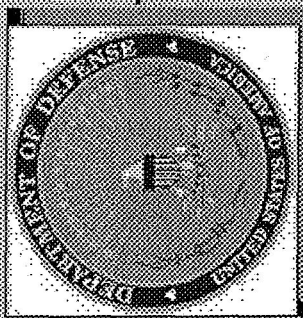
The reports were part of a collection of documents that congressional investigators released last week, showing that Ford



Automobile without TREAD Act



Unique Item Identifier (UID)

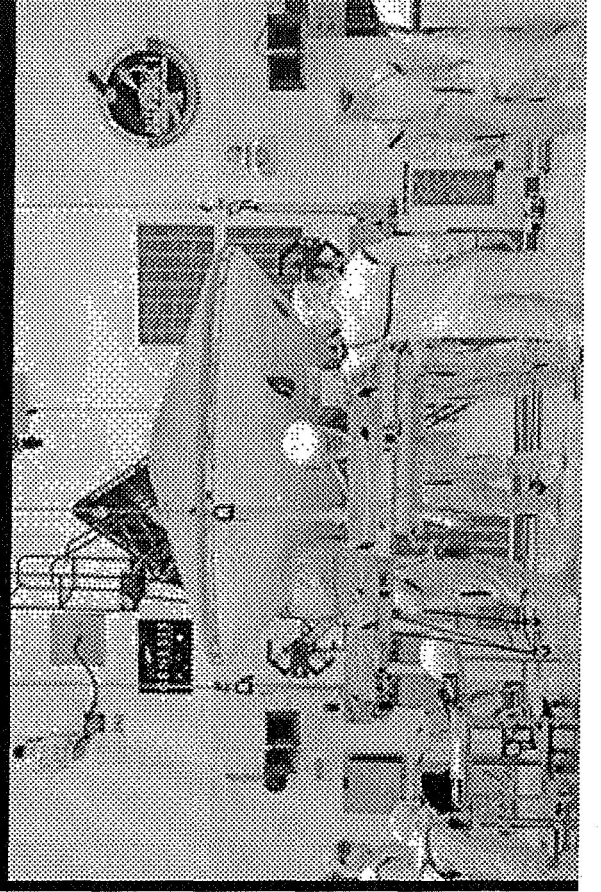
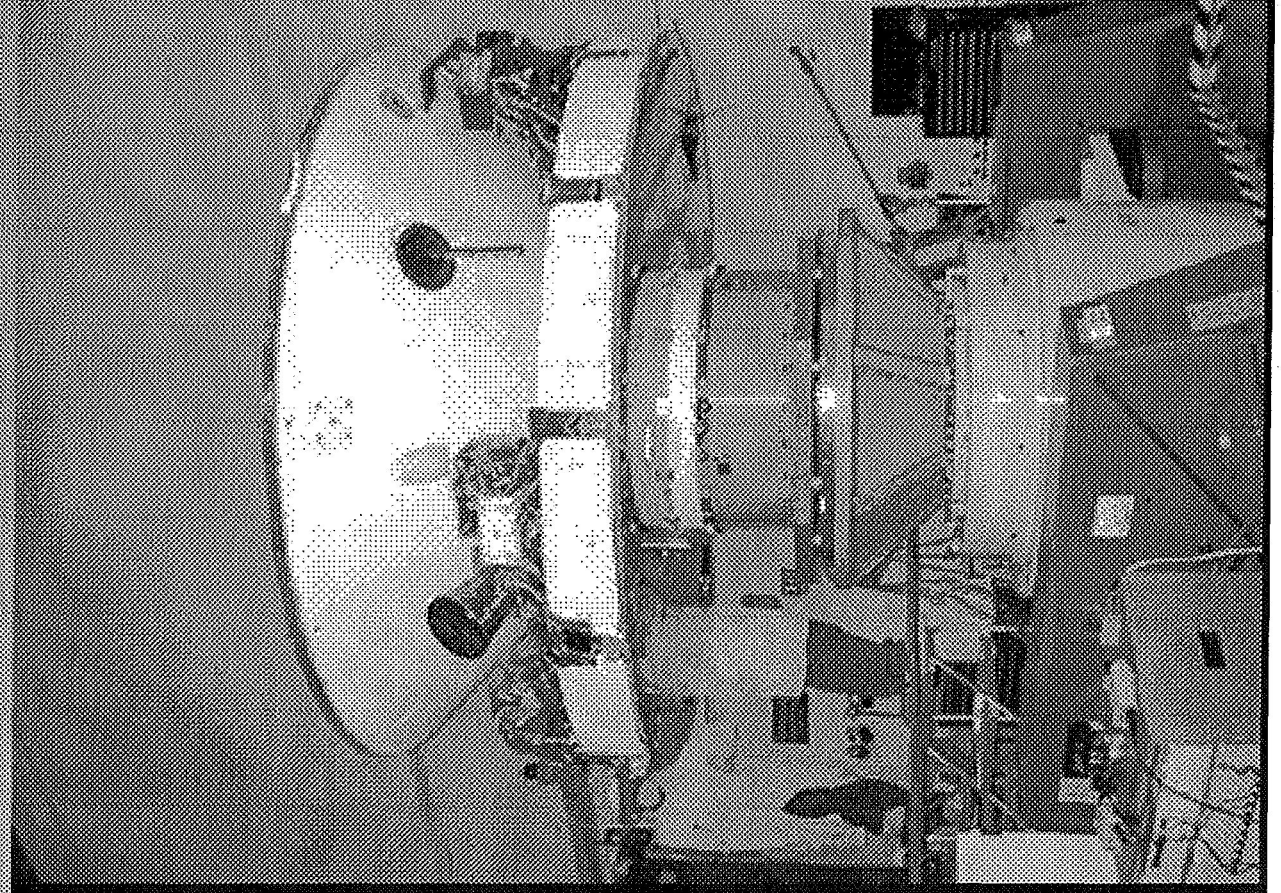
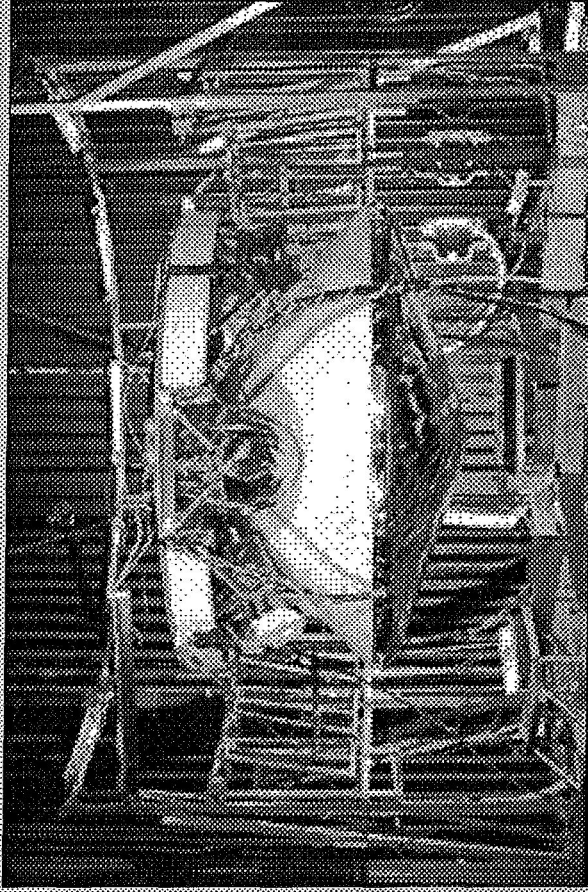


An Impossible Recall

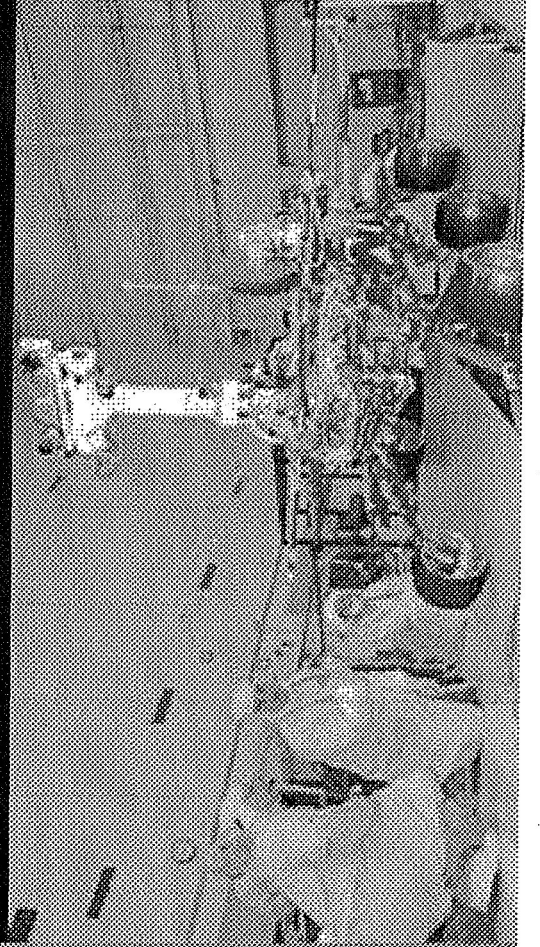
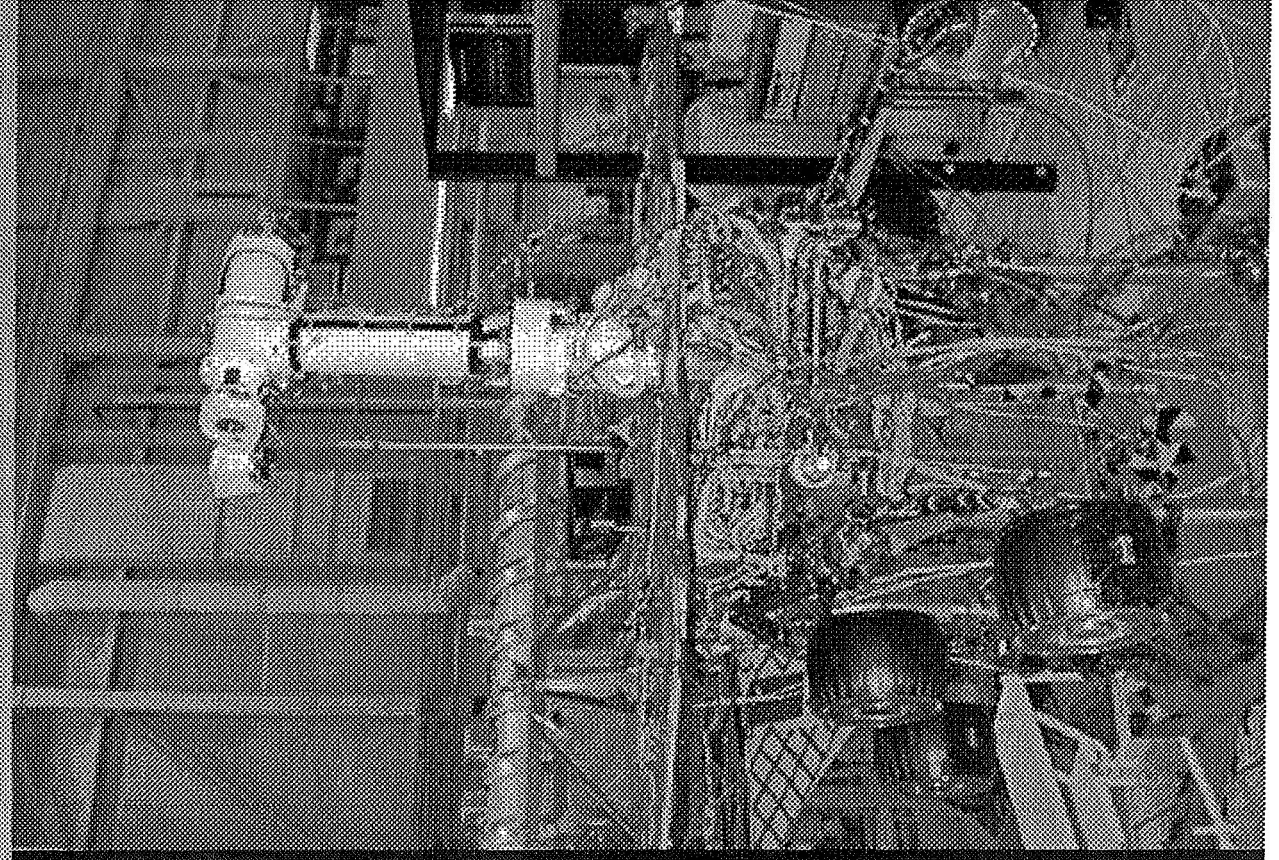
NASA's Recent Venture

Tire Tracks on Mars

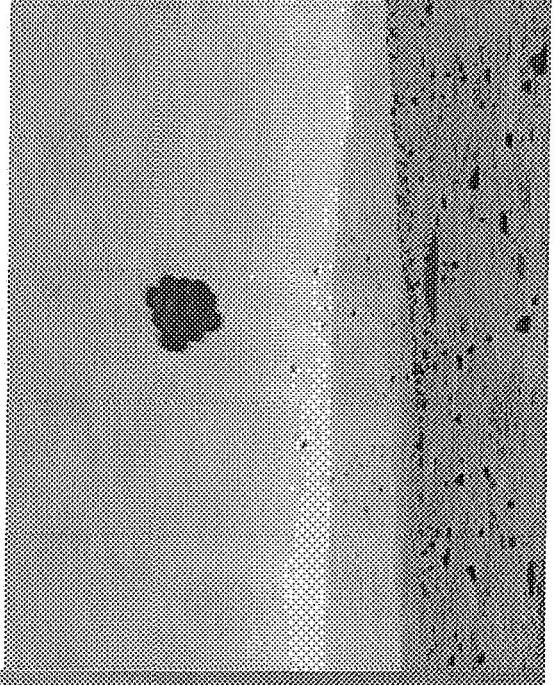
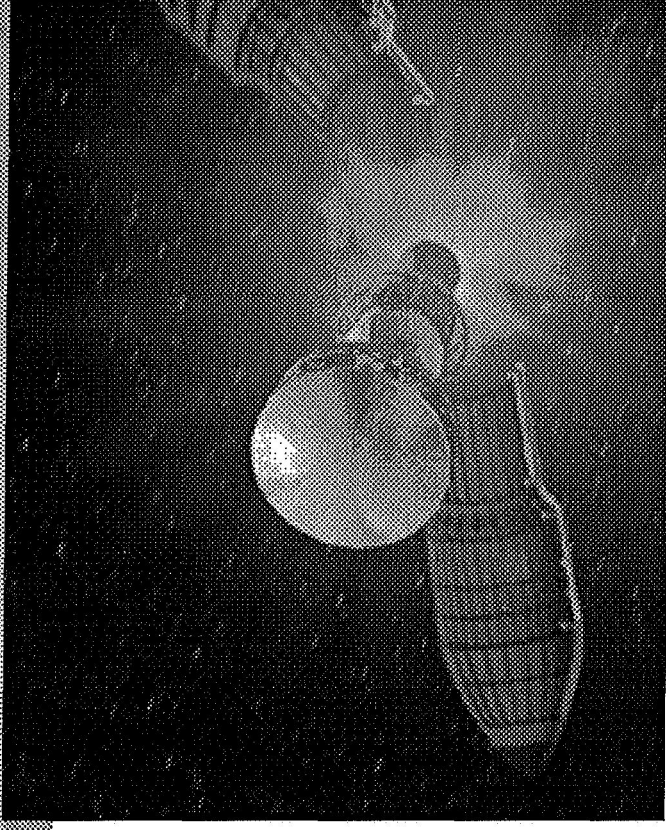
Delivery System



New SUV Was Produced



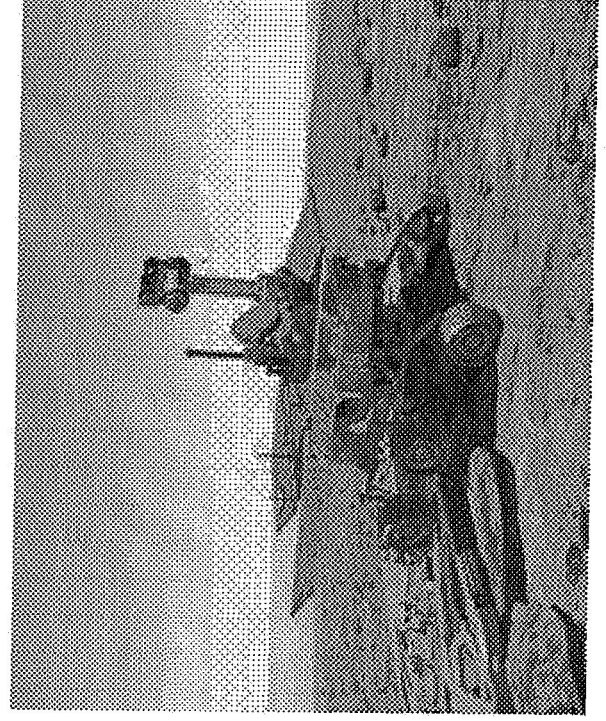
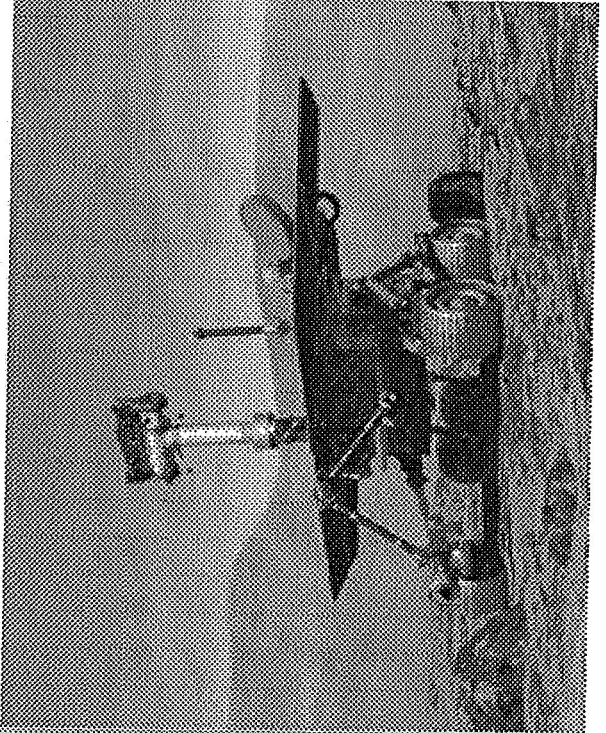
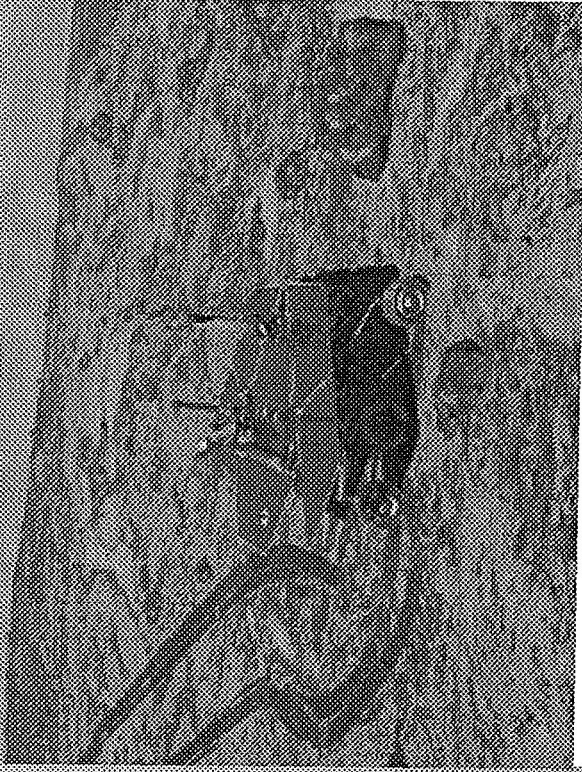
New Brake System



New Shocks, Too

Use Once and Discard

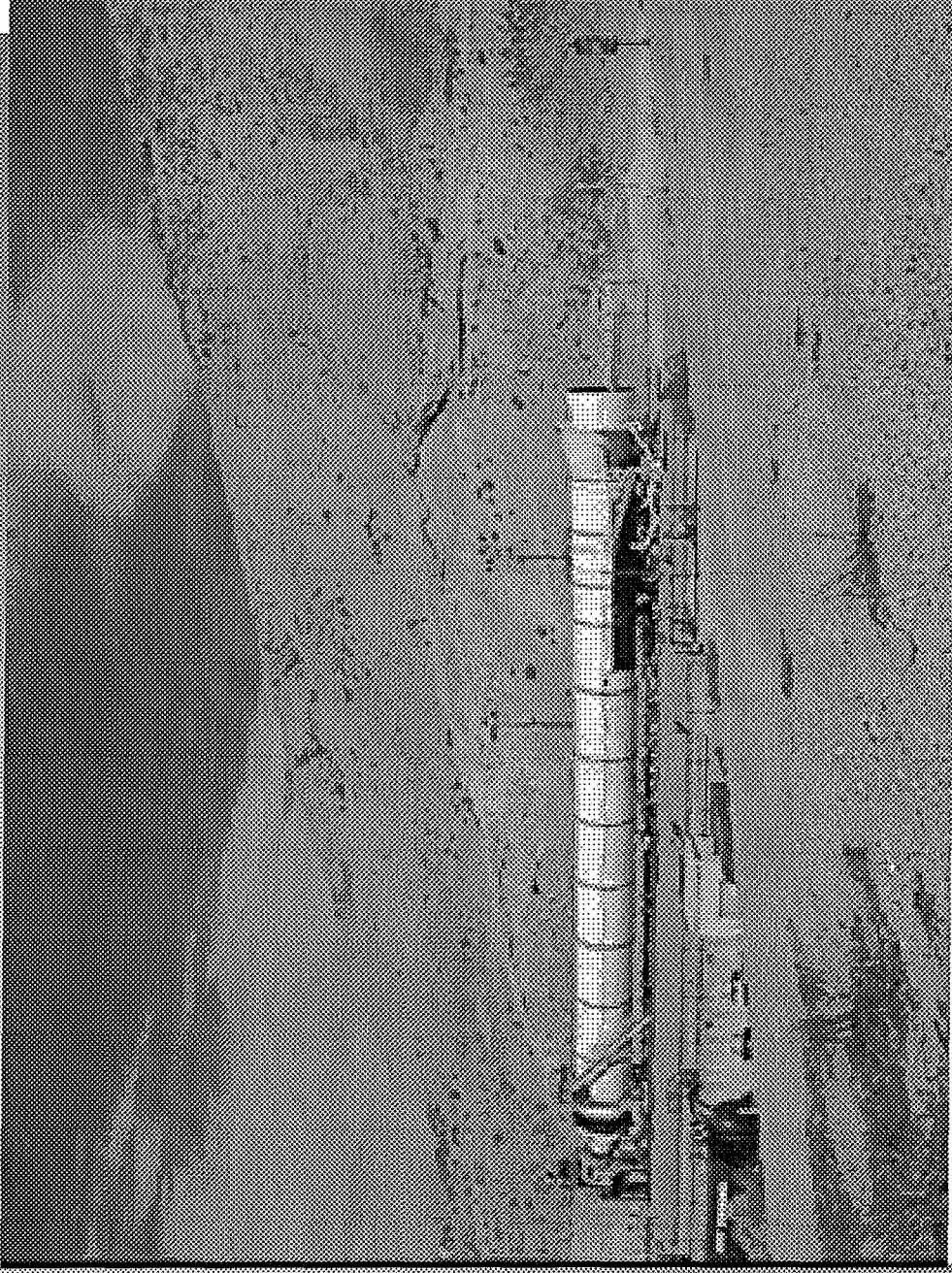
Catchy Name—Mars Rover “Land Rover” and “Range Rover” Already Used



Traceability of Critical Parts Why It Is Important To NASA

- **Design Safety Factor of 1.4+**
- **Continued Testing to Validate Safety Factor**
- **Fleet Leader Condition (What Is Failing)**
- **Where Are All the Parts Like the Failed One**
- **How Do Only the Bad Ones Get Replaced**

Traceability of Critical Parts Test for Life Extension



Learn to Test

Test to Learn

Failures Provide

Recall Information

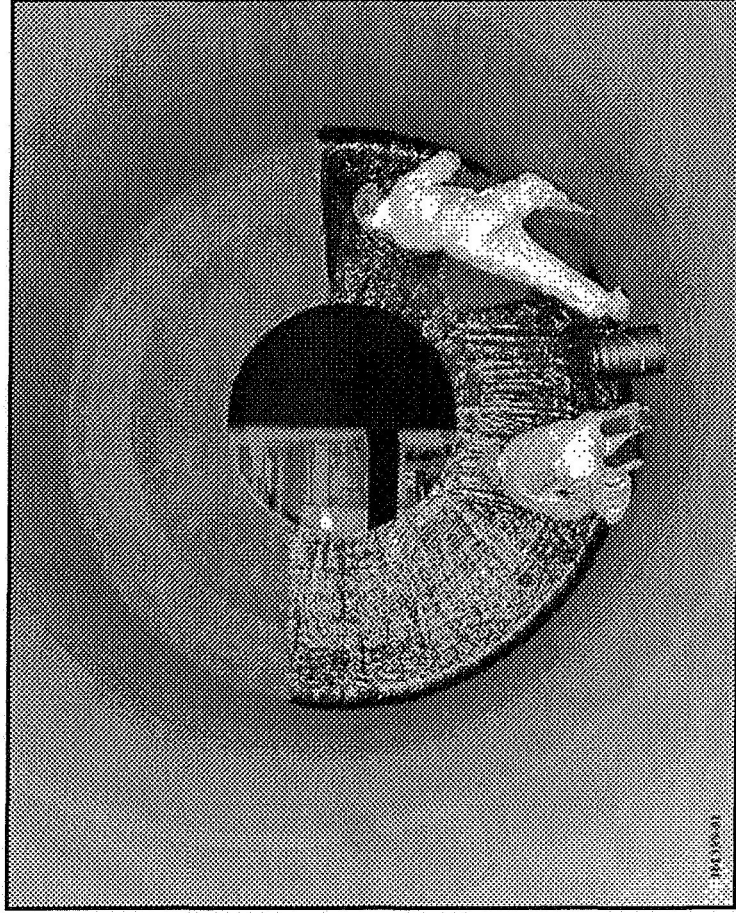
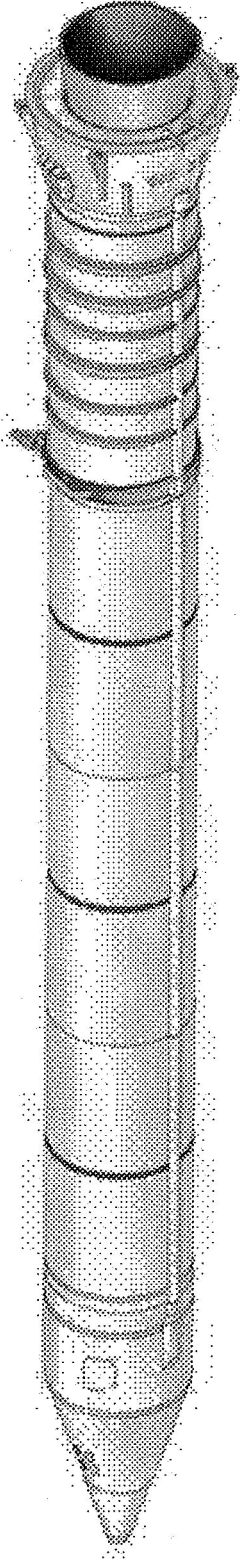
This and other RSRM information compliments of:



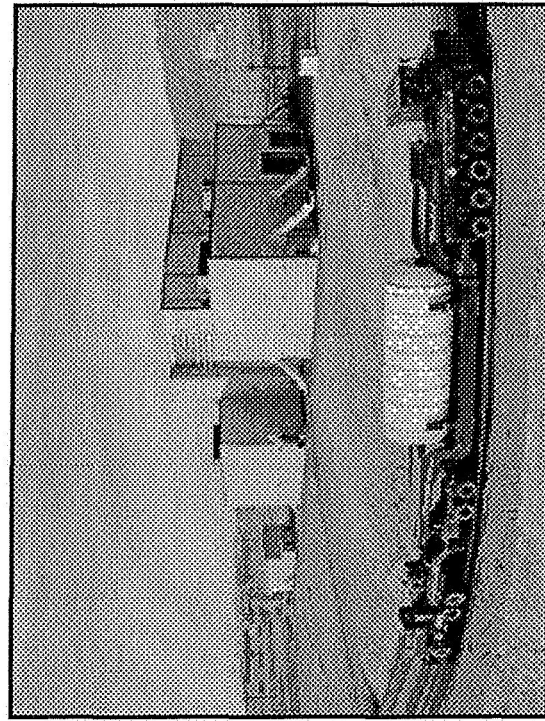
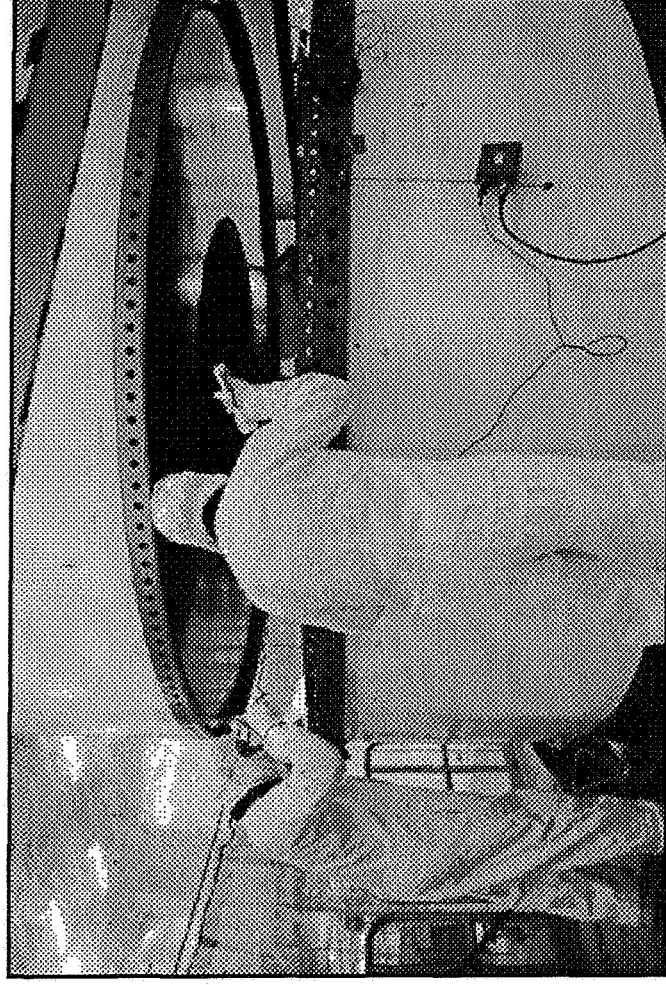
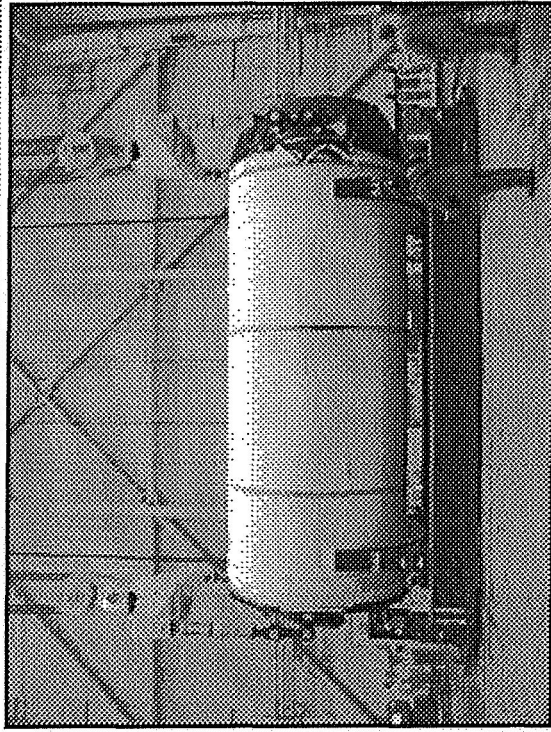
ATK THIOKOL PROPULSION

Traceability of Critical Parts

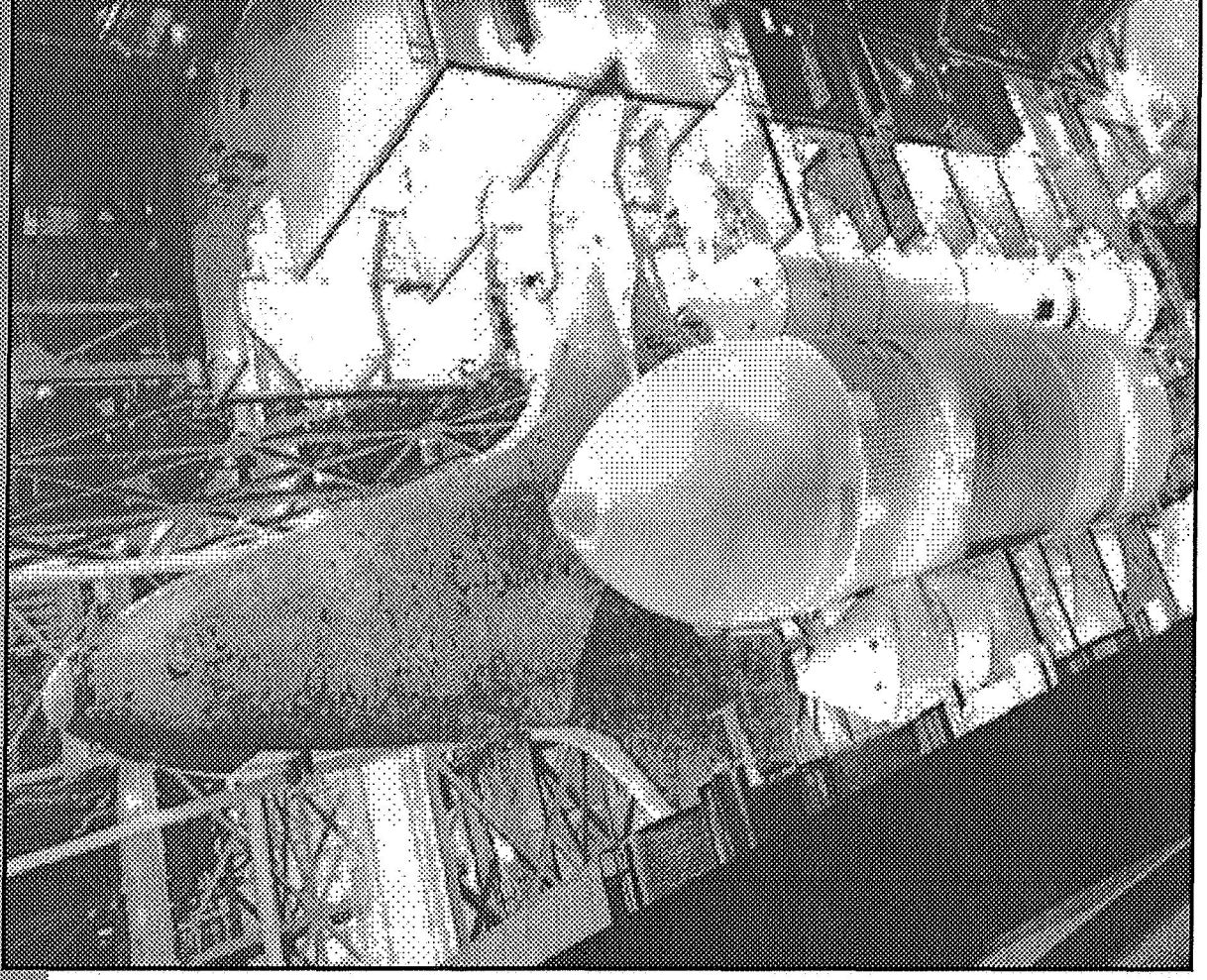
Reusable Solid Rocket Motor



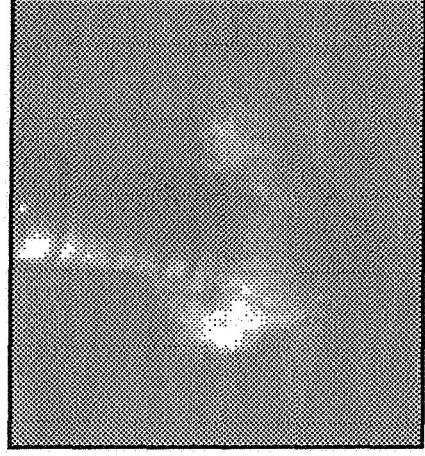
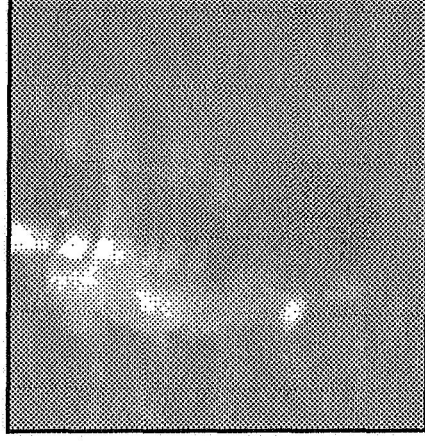
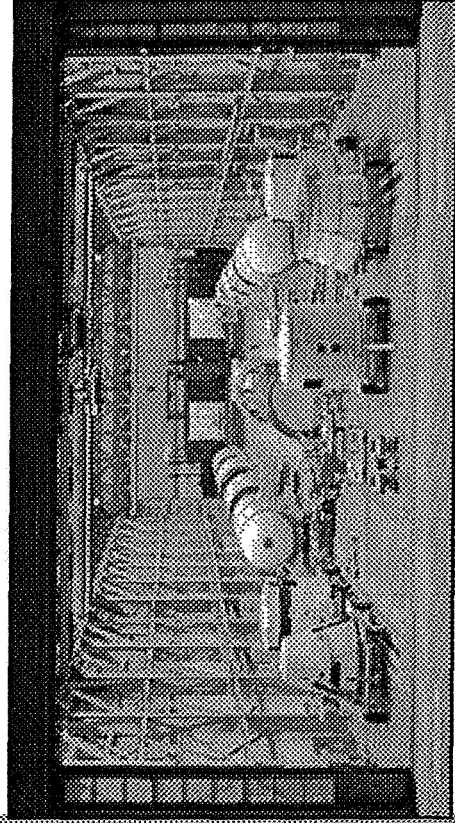
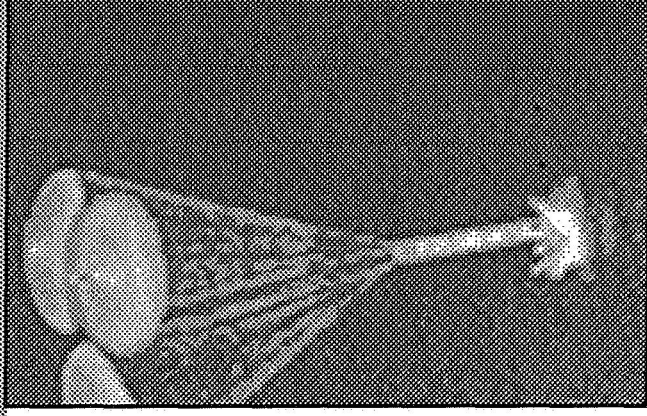
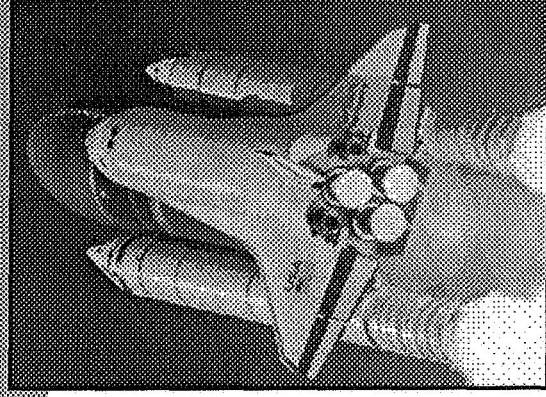
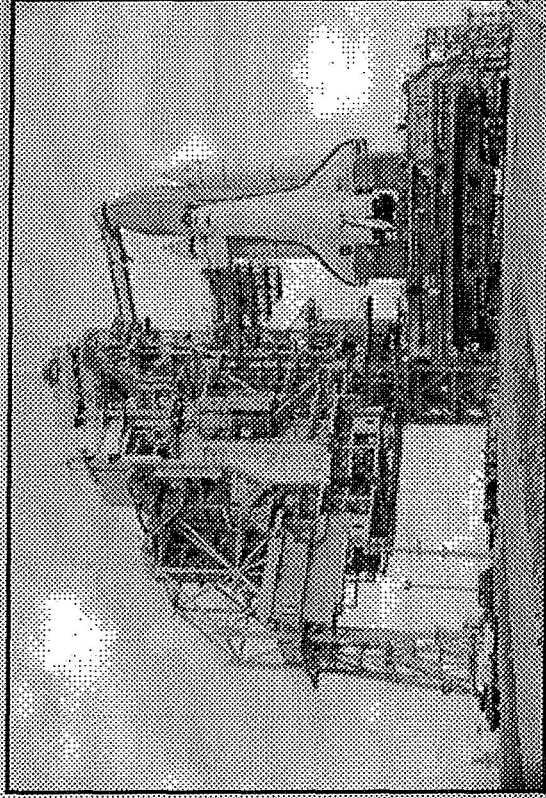
Traceability of Critical Parts



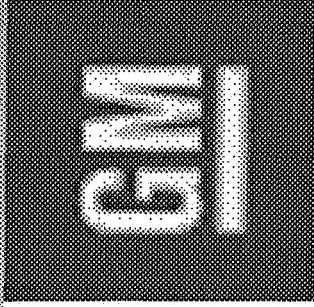
Traceability of Critical Parts



Traceability of Critical Parts

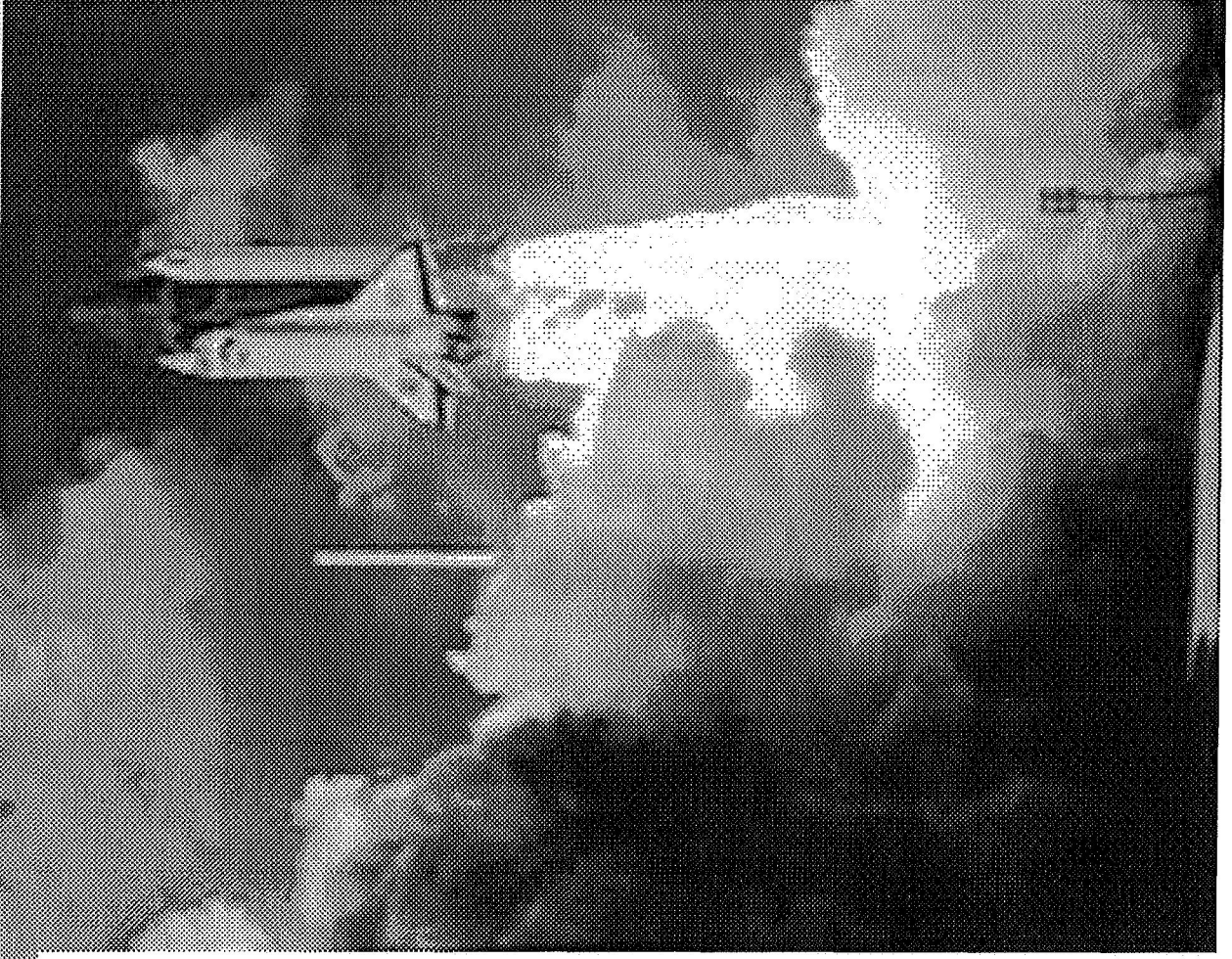
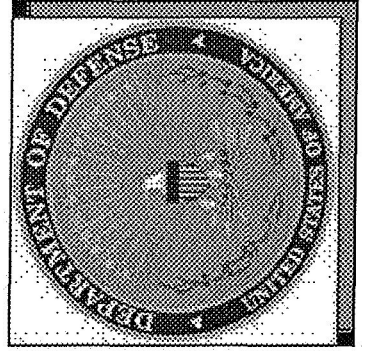


Traceability of Critical Parts Starts with Identification



*Part Numbers and Serial Numbers
Identify One Part From the Other*

*CAGE Numbers Identify One
Supplier from the Other*



Automatic Identification Used at Many Levels

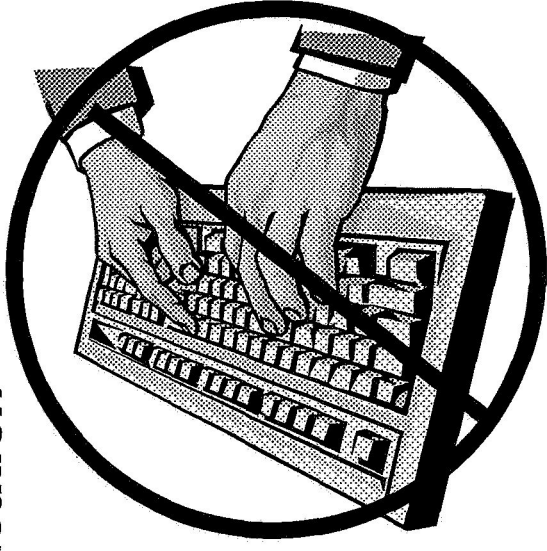
Bar Coded Labels That Are Adhered to or Printed on the Product

Direct Part Marked Visible Permanent Identification

Direct Part Marked Hidden Permanent Identification

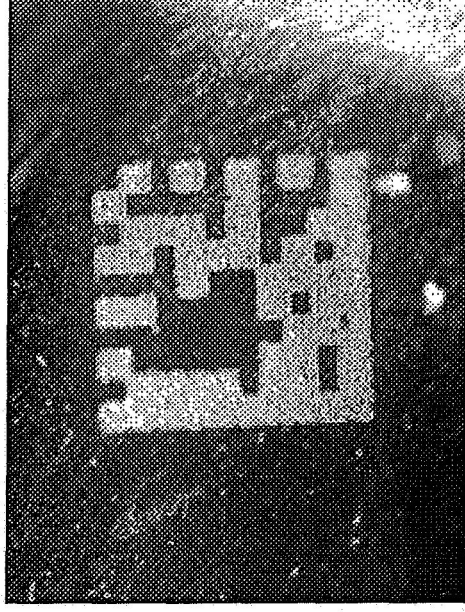
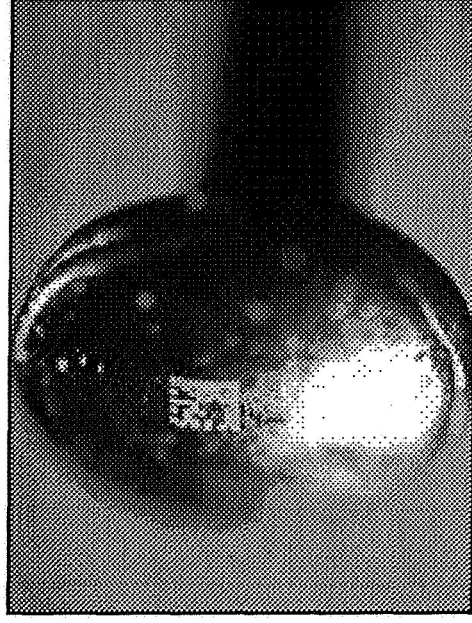
RFID

Nanocodes™



***All Technologies Must Work Together In the IT World....
Traceability Depends On Automatic Identification Working
With Automatic Communication For The Right Results***

Automatic Identification Choices



Above: 10x10 matrix symbol on the head of a straight pin

Bar Code
Labels
Are
Cheap...
Mature...
Reliable...
Widely Available
Technology

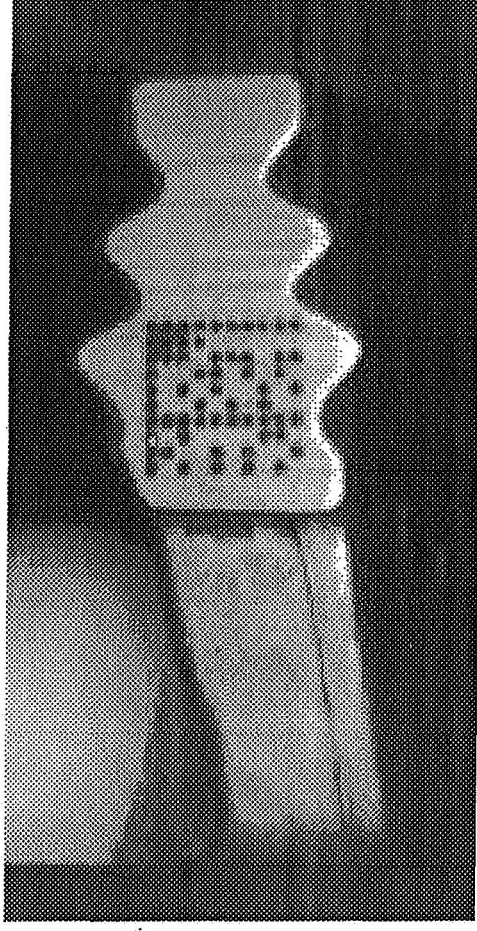
***But If There Is Not Room for a Bar Code Label
or if a Permanent Mark Is Required... Use 2D***

Direct Part Marking

Direct Part Marking

NASA's Primary Emphasis
.....Item-Level Traceability
.....Track the Piece

Know the Pedigree
.....Know who made it
.....Know who marked it
.....Know who stands behind it

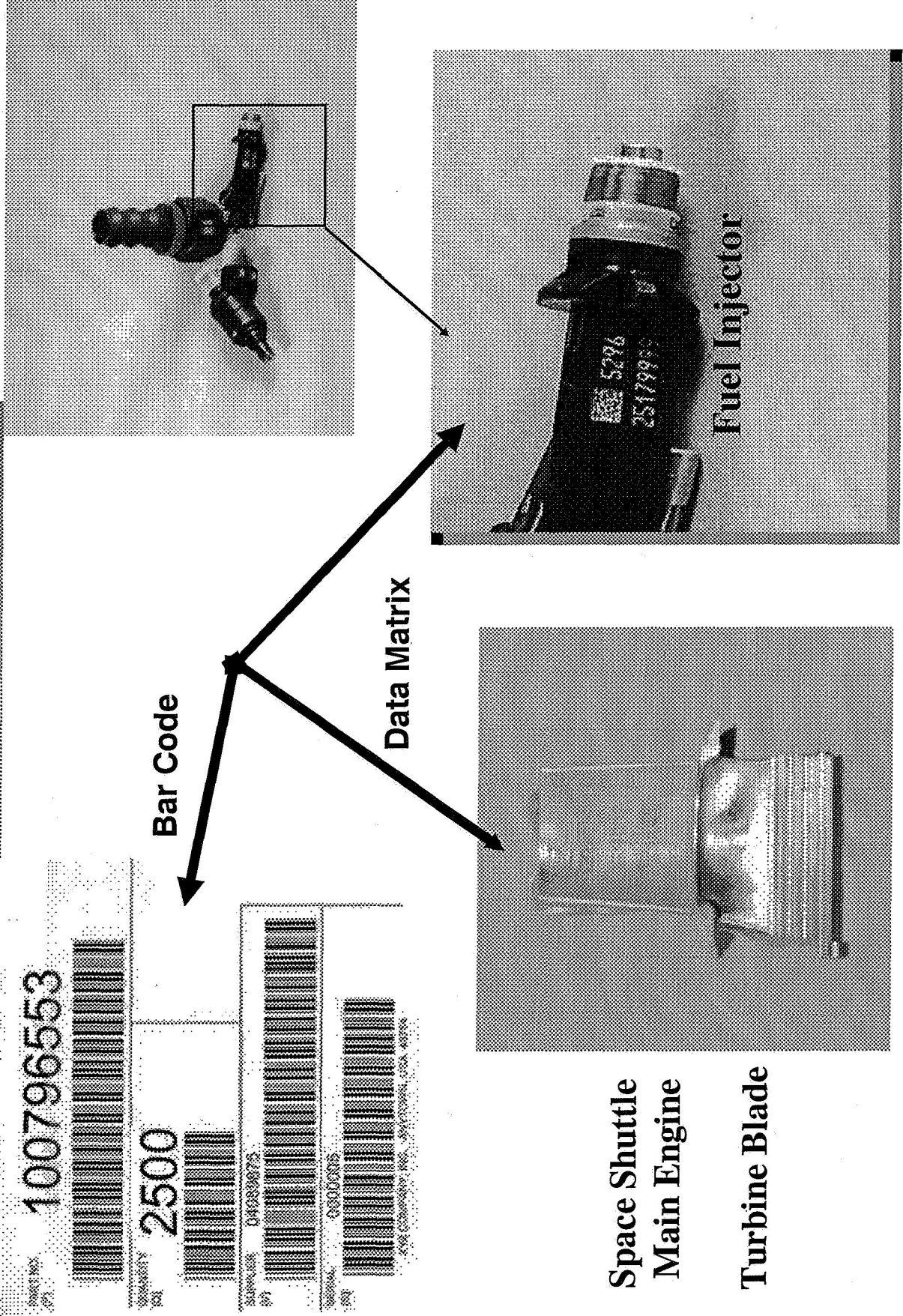


Above: 10x10 matrix symbol
on the side of a turbine blade

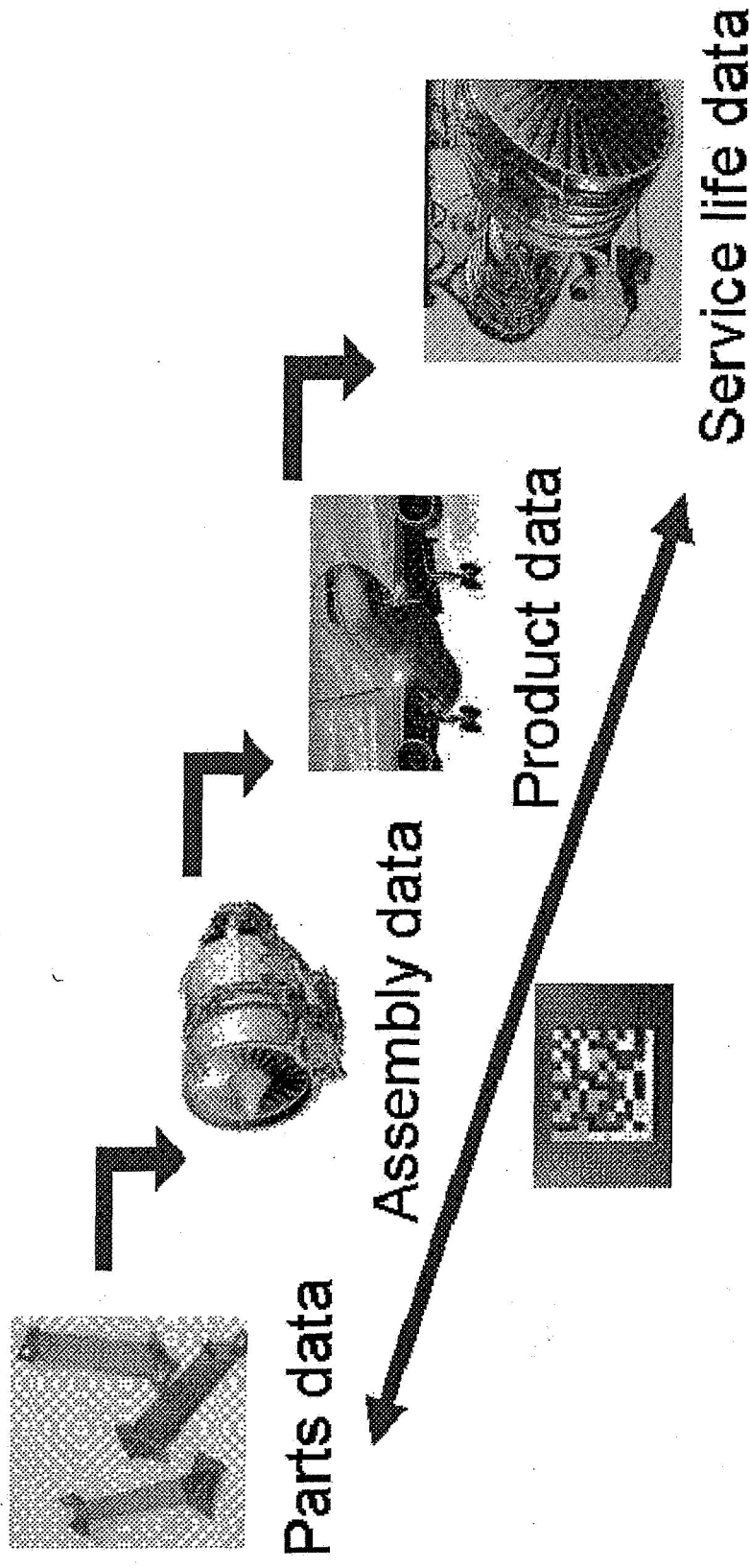
*Lest We Forget
A Mark is a Controlled Defect
Properly Done—It Is a Flawless Imperfection*

Automatic Identification Starting Points

All ID Must Work Together

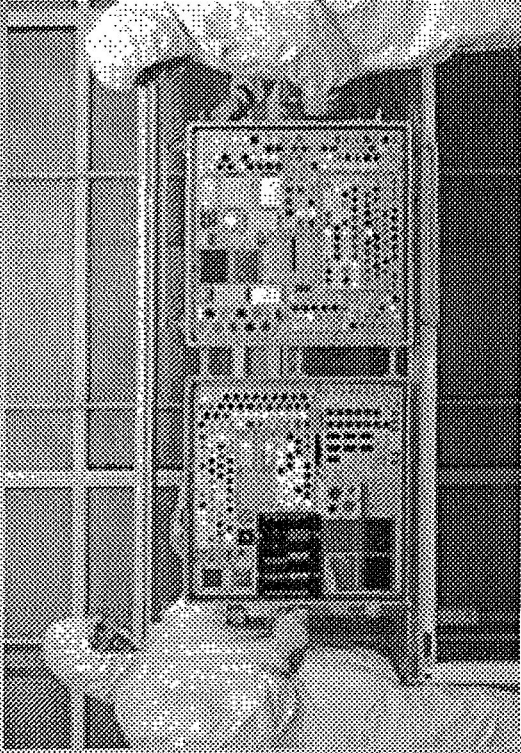


Direct Part Marking Enables Life Cycle Tracking

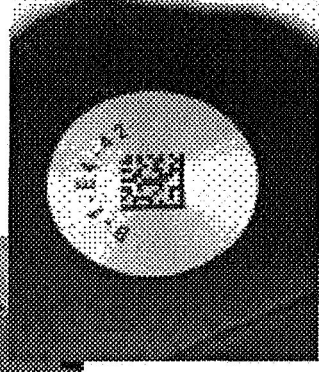
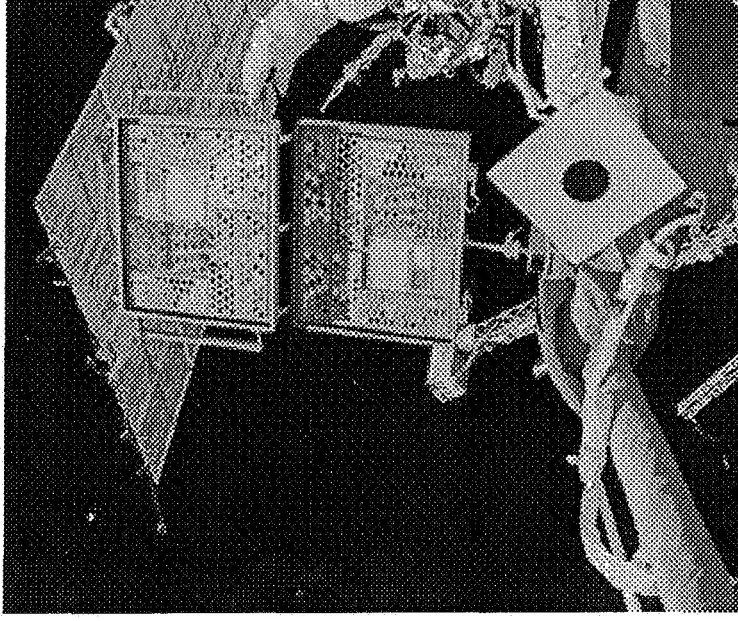


Data Matrix Codes Marked On The Parts Provide The IT Link

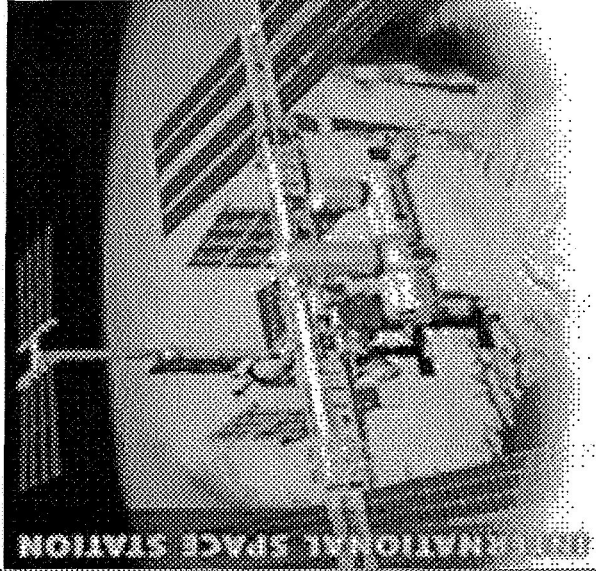
NASA Has Unique Marking Problems and Unique Testing Methods



The Columbia Accident Extended
The
Exposure
Period
To
4 Years



The Plan Was To Expose
The Samples to Space
For A Year...But



NASA Has Unique Retrieval Methods

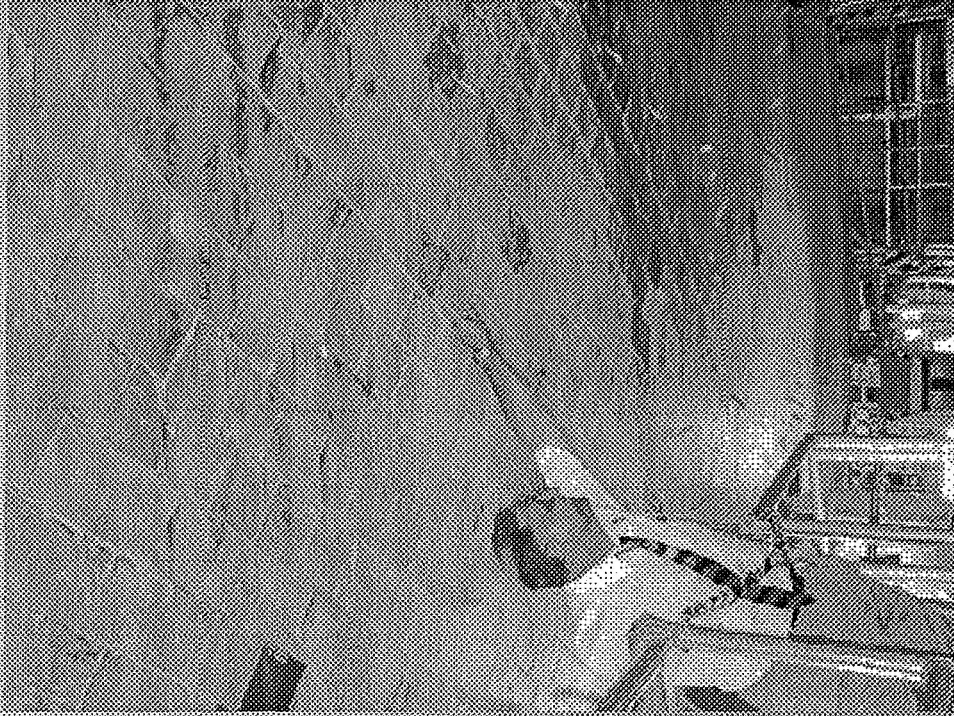
The Astronaut Was In The Vicinity and Retrieved The Experiment on First Flight.

All Samples Looked Good As New Except Copper Coating Turned Green.

Micro Meteoroid Impacts Noted on One Sample

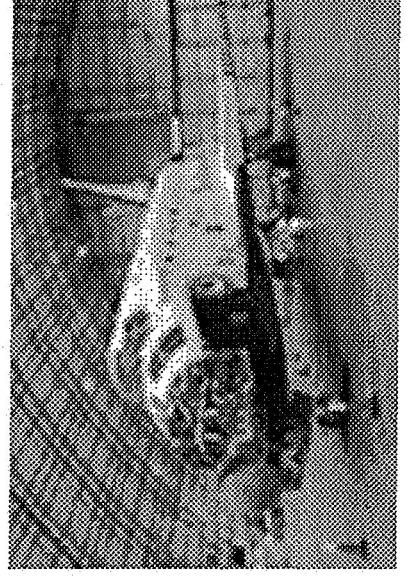


NASA Tested Thermal Protection Tile Marking Method



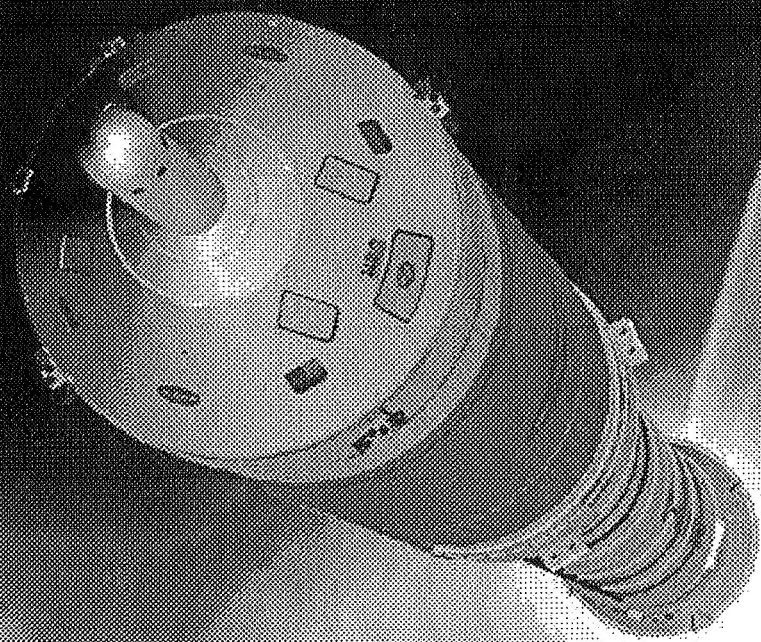
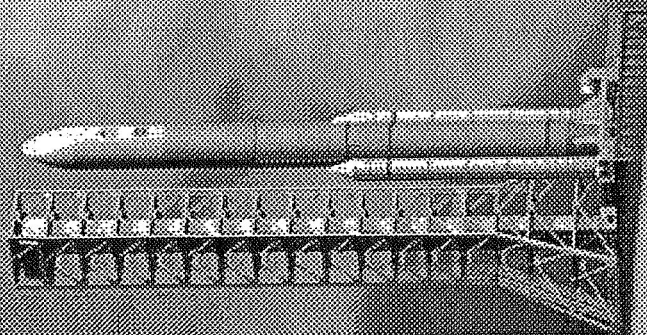
Thermal
Protection
System
Tile

16 Times in
Space
on OV-103
(Discovery)

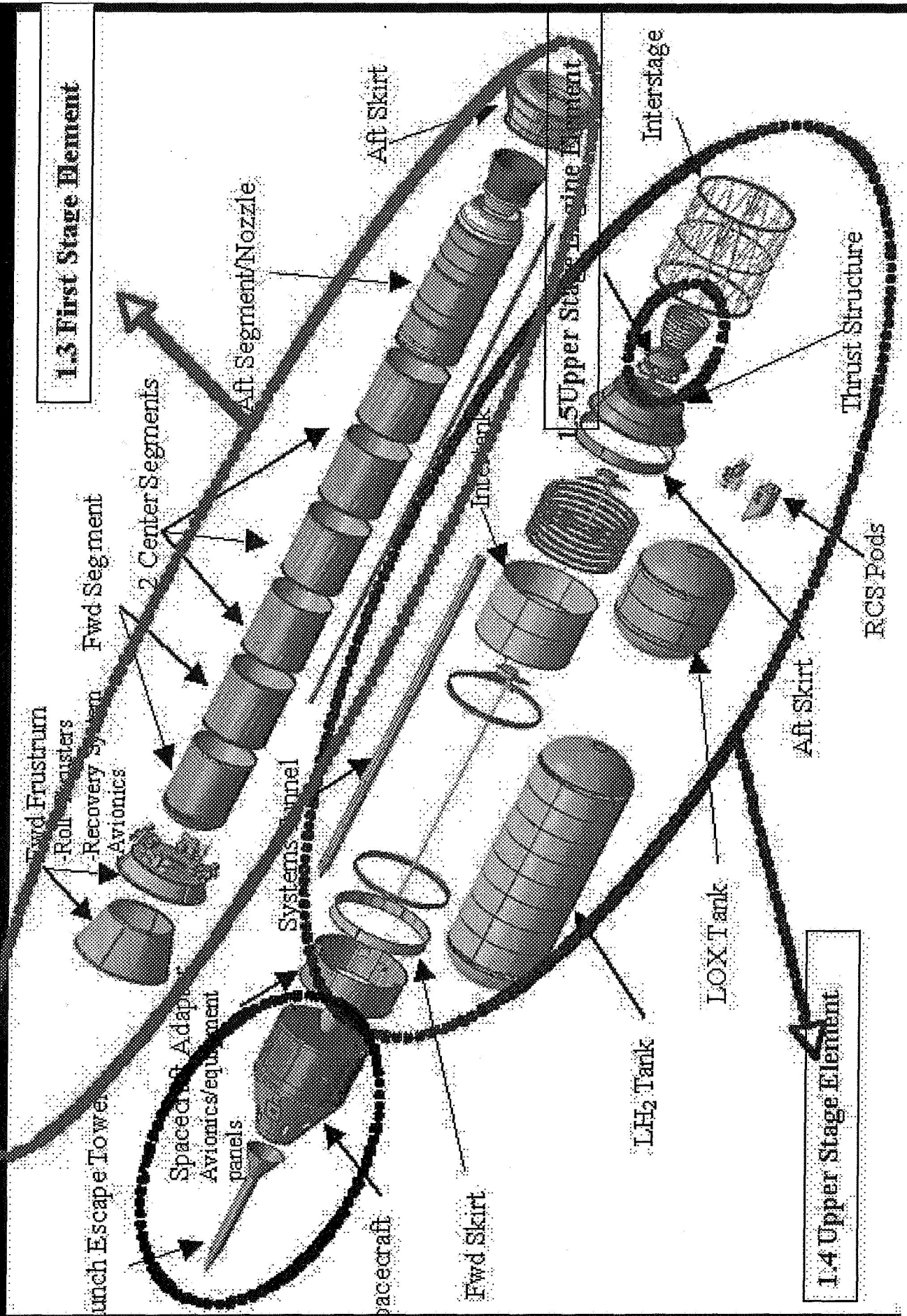


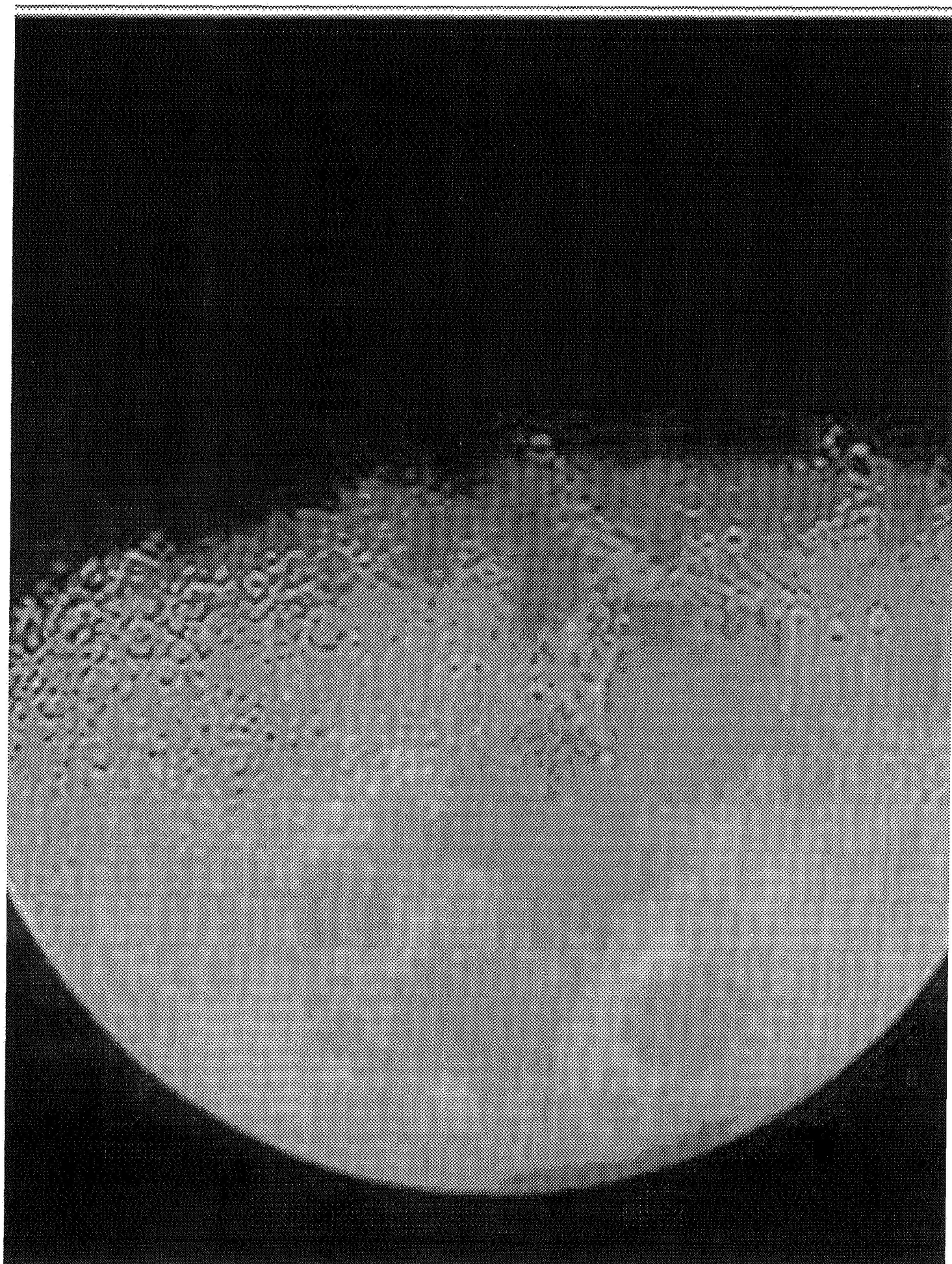
Looked Good
And
Readable

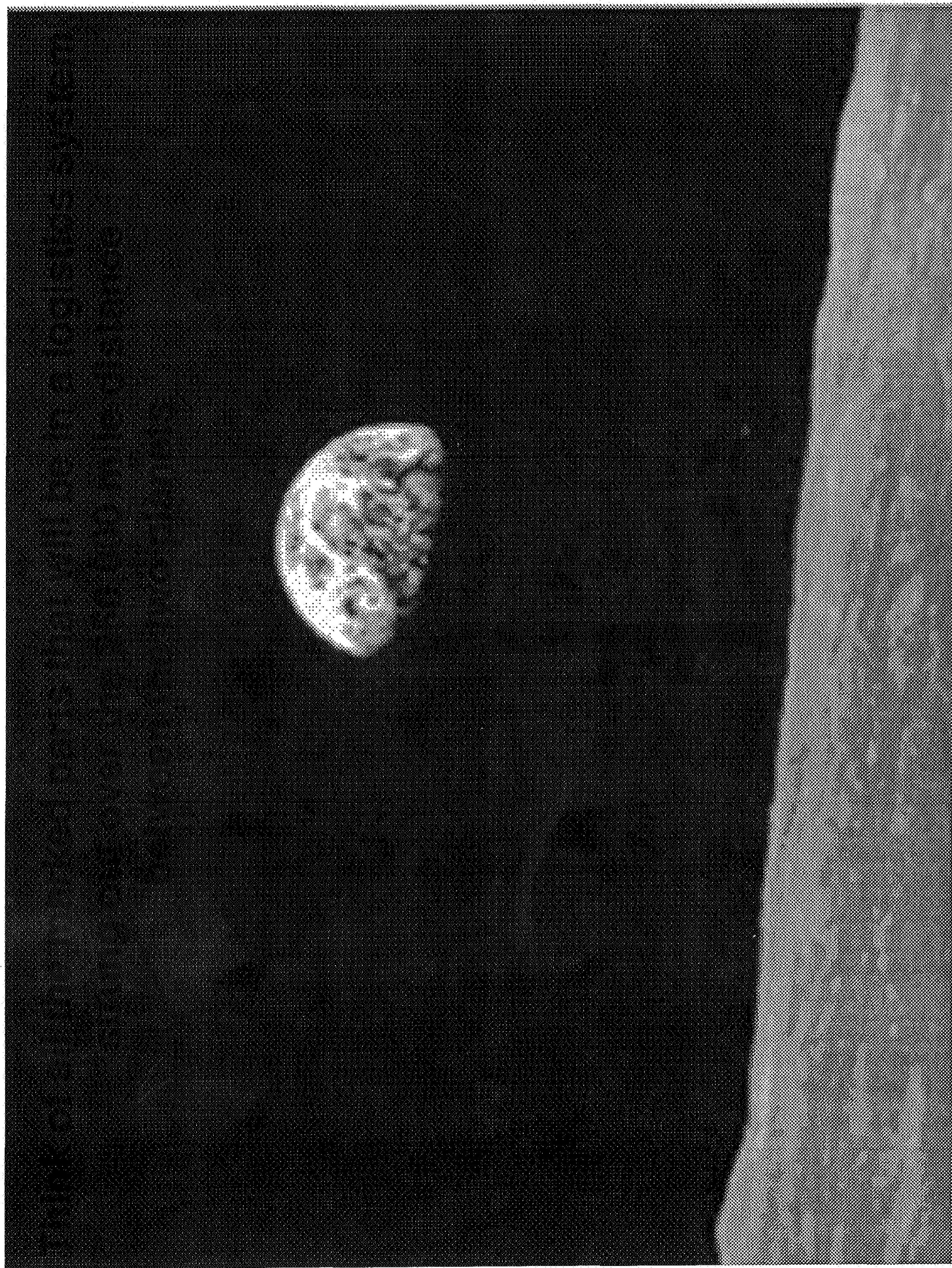
New Launches



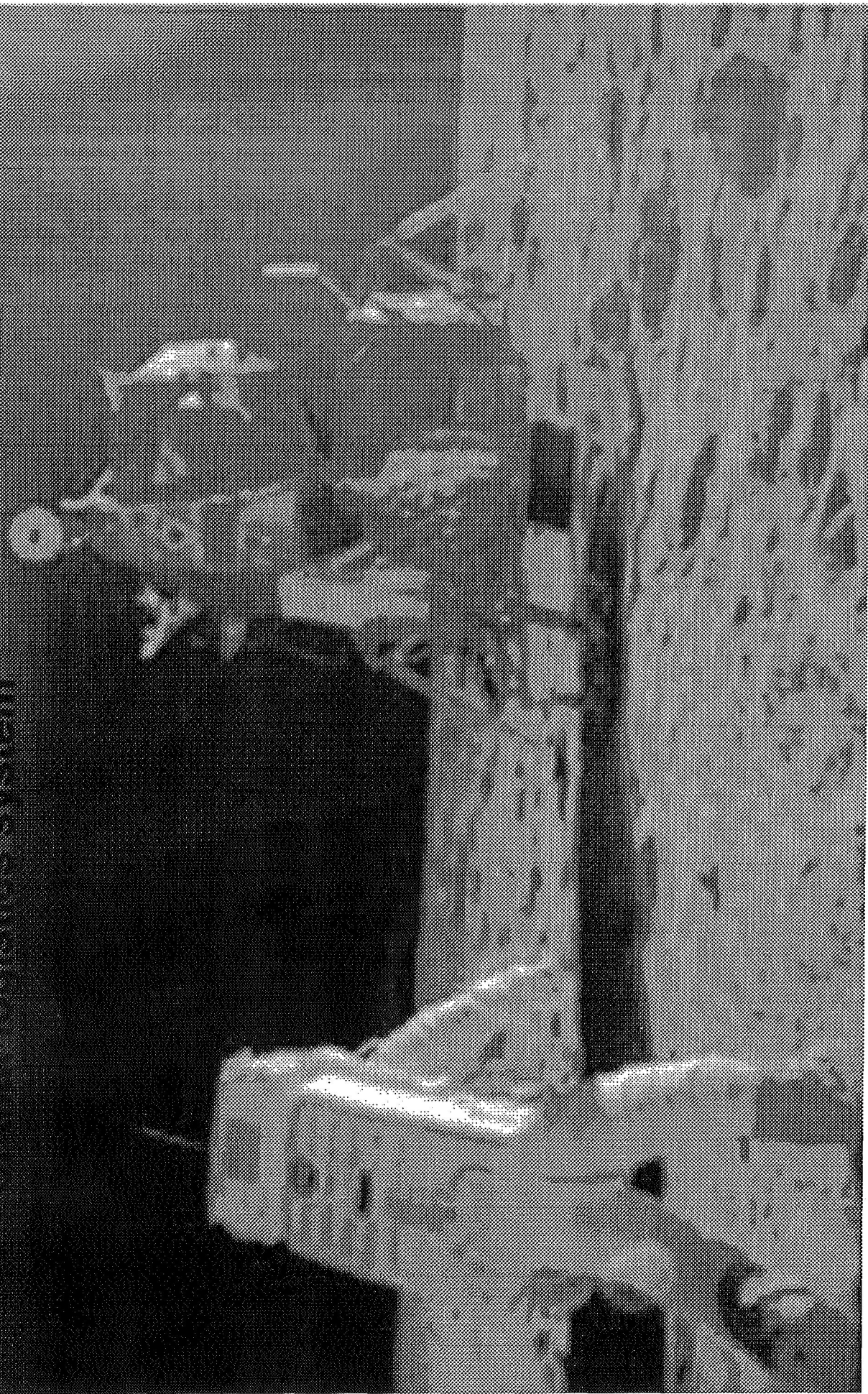
Crew Launch Vehicle for Constellation

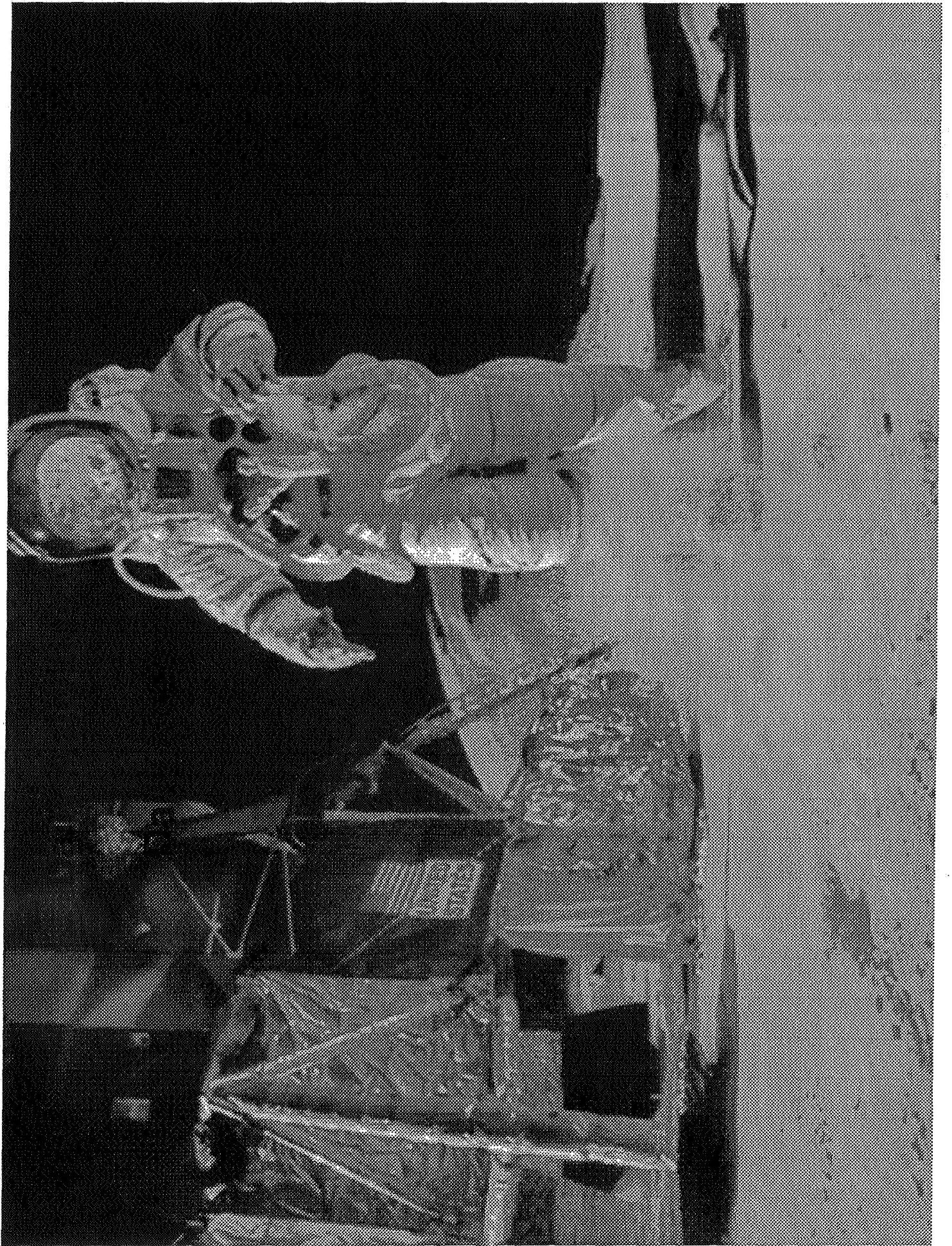


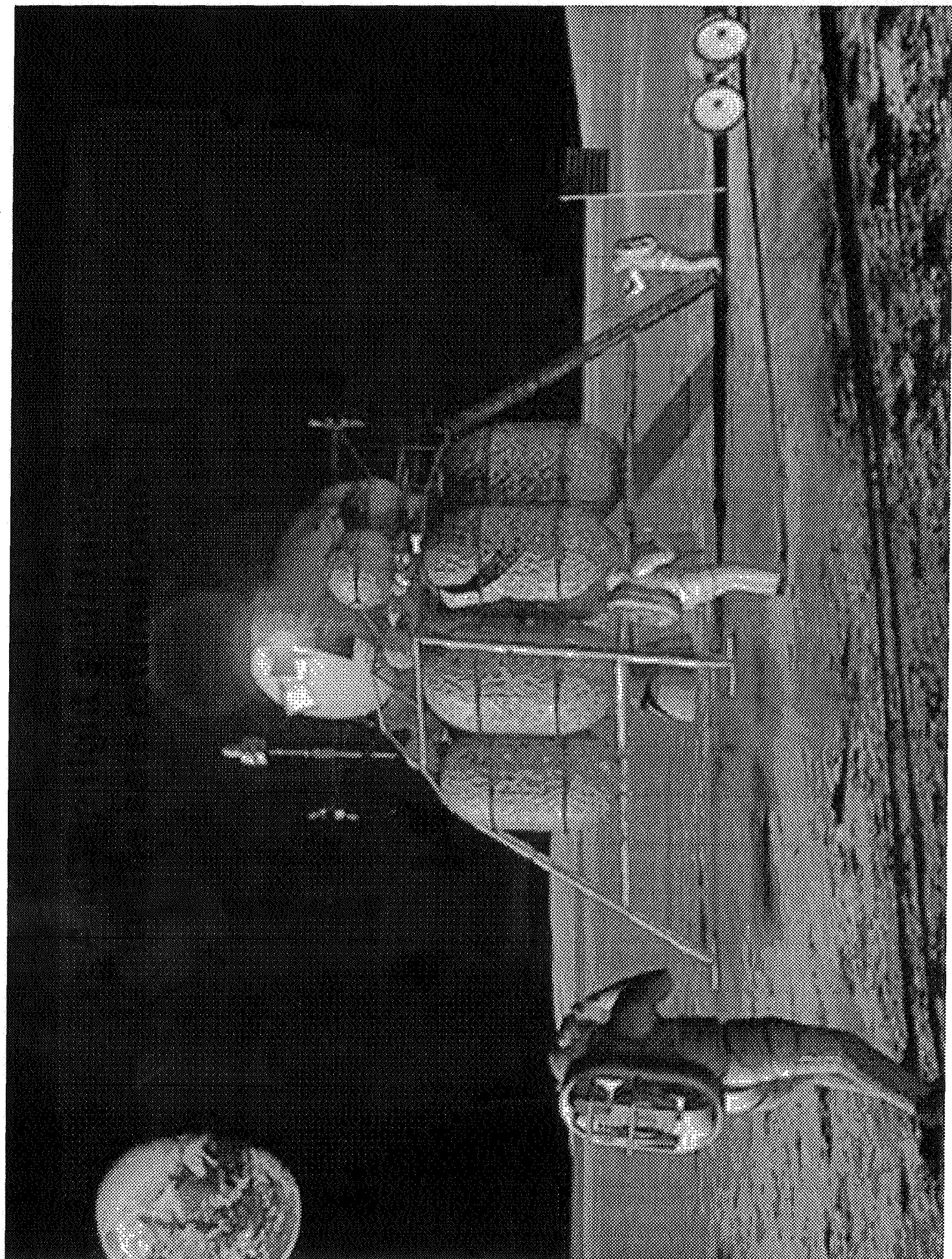




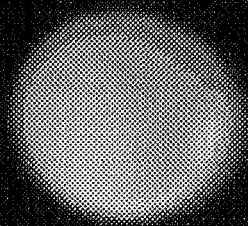
...for the people whose lives
will depend on the accuracy
of that logistics system







And all
spread across
spread across





Daily Activities

Daily Needs

And the right stuff there
for the safe return home

Space Systems... There Are Some Direct Part Marking and Reading Problems

Some Crazy Solutions

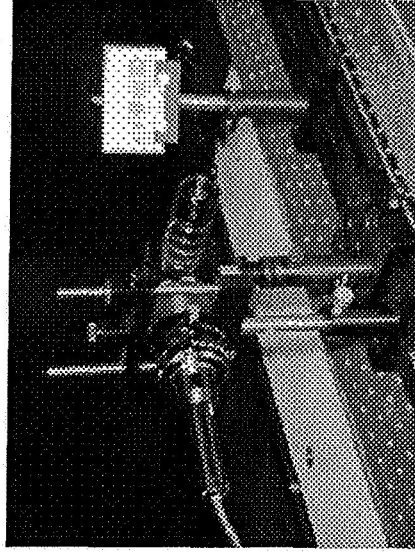
Product ID Problems That Required New Technology

- **No Contrast Marks**
- **Curved and Shiny Surfaces**
- **Distance Reads**
- **Mark and Scanner Both Moving Independently**
- **Symbols Covered with Paint**
- **Chemical Tags Not Recognized as Codes**

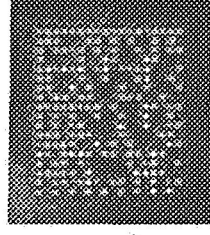
Solutions for Visible Marks

One Reading Remedy... *New Pair of Glasses from Space Station*

NASA Optical Scanner For Visible Marks

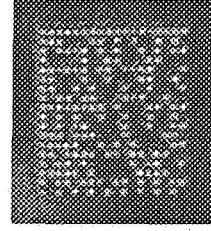


No contrast mark
on smooth aluminum
at 30 degree angle

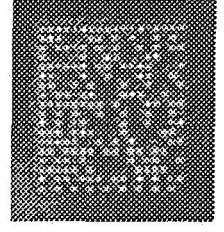


2'

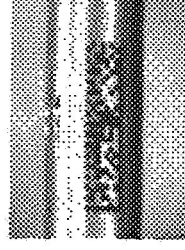
20'



60'



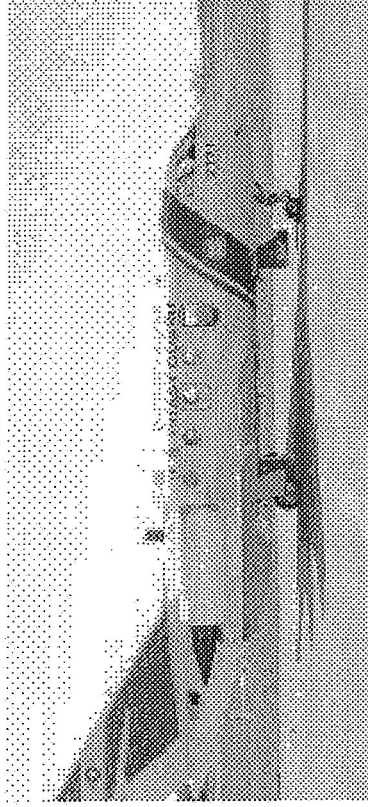
Shiny screwdriver



New Distance Capability Being Developed

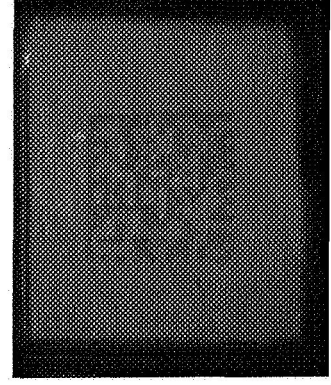
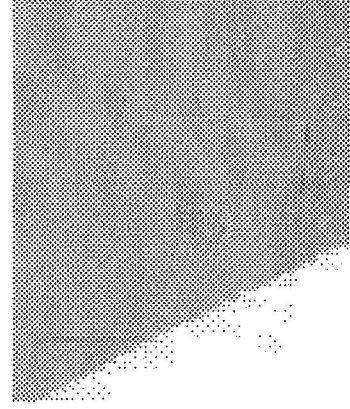
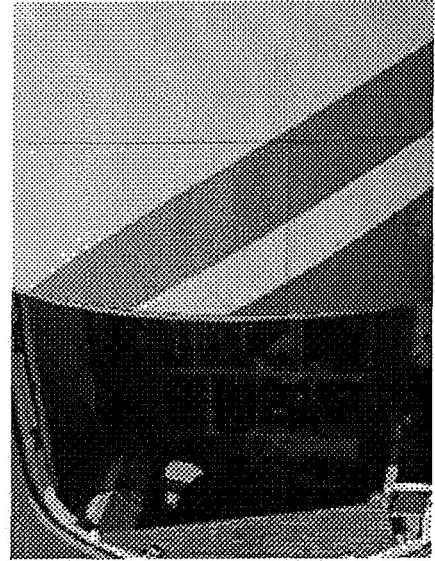
Solutions for the Painted Part ...Read through the Paint...

Magnetic



*Mark Survived
18 Months of
Coast Guard Duty*

Mark Decoded

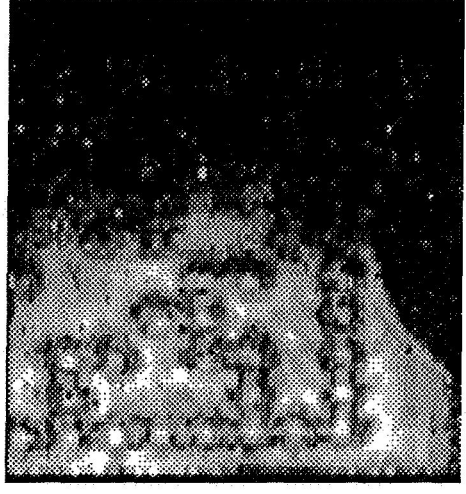
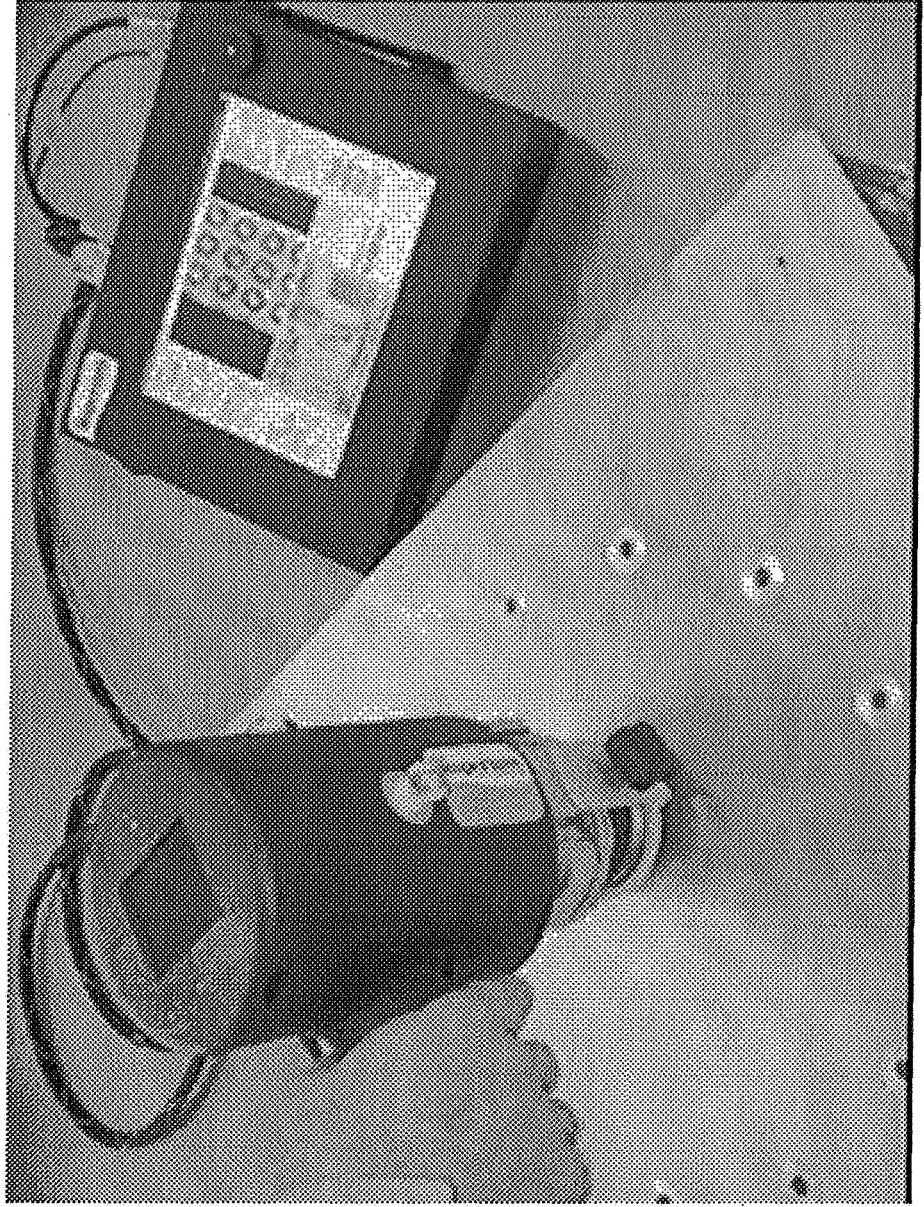


Solutions for the Painted Part ...Read through the Paint...

Ultrasonic

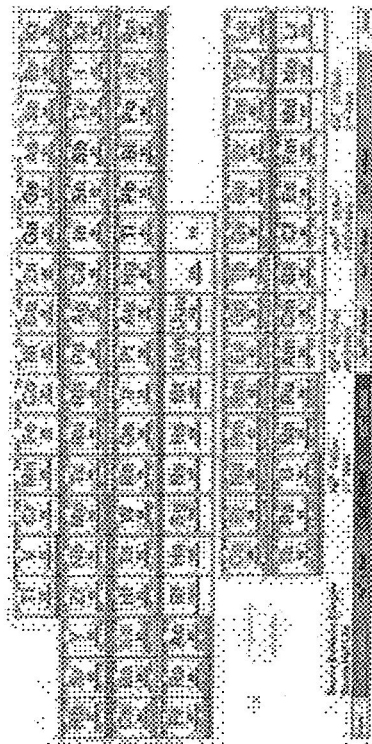
Reads through
6 Layers
of coatings

Detects density
and
surface height
changes



Solutions for the Unmarkable Part ...X-ray Fluorescence...

Nanocodes™



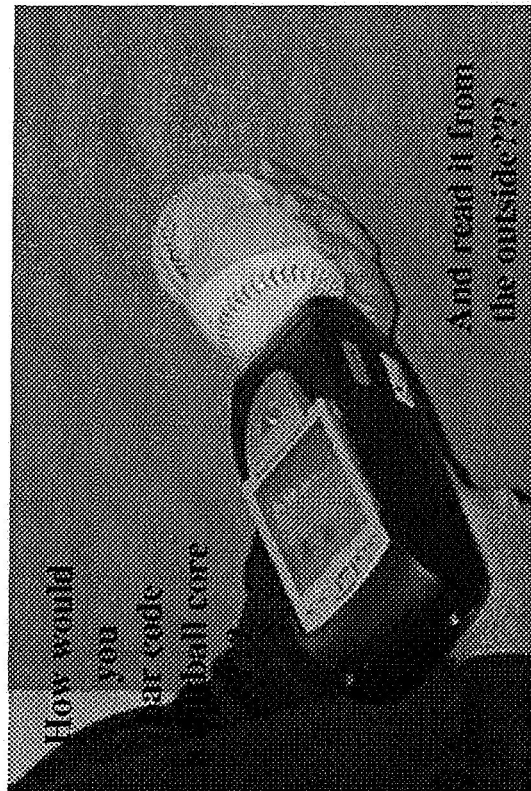
Conversion



X-ray fluorescent
“chemical
bar code”

**Matches to the
Supplier Code**

Software converts
to ASCII
and symbol of choice



How would
you
bar code
ball core

And read it from
the outside???

Solutions for the Unmarkable Part X-ray Fluorescence

Nanocodes™

*How would you
do it ???*

Bar code a cultured
pearl...
on the seed...
without a surface
change...
plant it in an oyster

Then read the bar code
two years later when
the pearl is formed....



Conversion =>



Intrinsic Secret Identification

Nanocodes™

How does an OEM prove that the part that failed was not made by the OEM?

XRF authenticates the product

CAGE Code.....5 Element Tag

XRF converts formats and ties to bar and matrix codes

XRF converted format is transparent to IT systems

XRF Nanocodes™

could be the next

generation expert witness

in liability cases!!!

Product Validation and Authentication

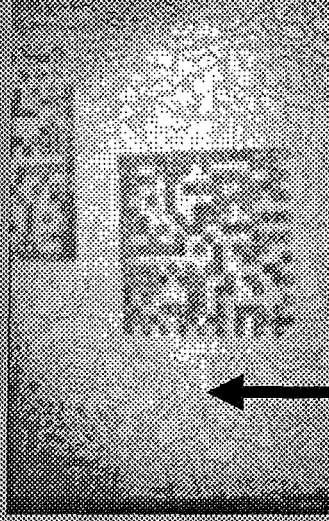
Automatic Identification Fully Integrated

(temporary to permanent to intrinsic marks for routine to the most secure product ID and validation matching)

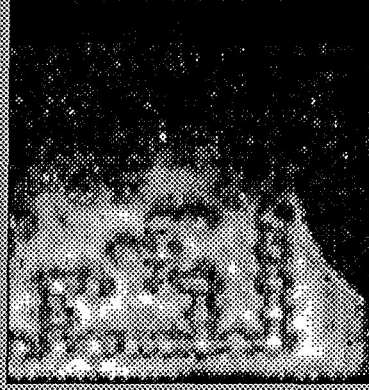
Direct Mark



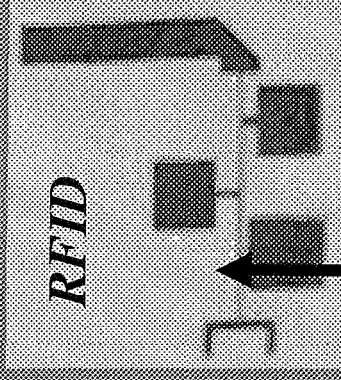
Visible



Magnetic

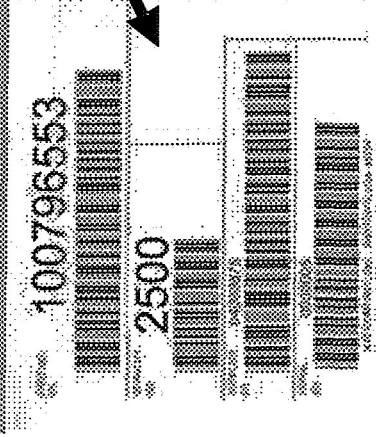
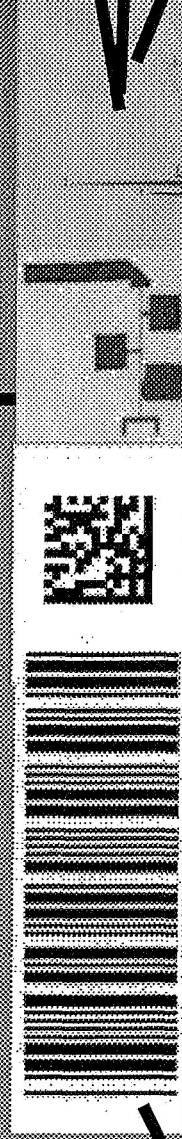


Ultrasonic



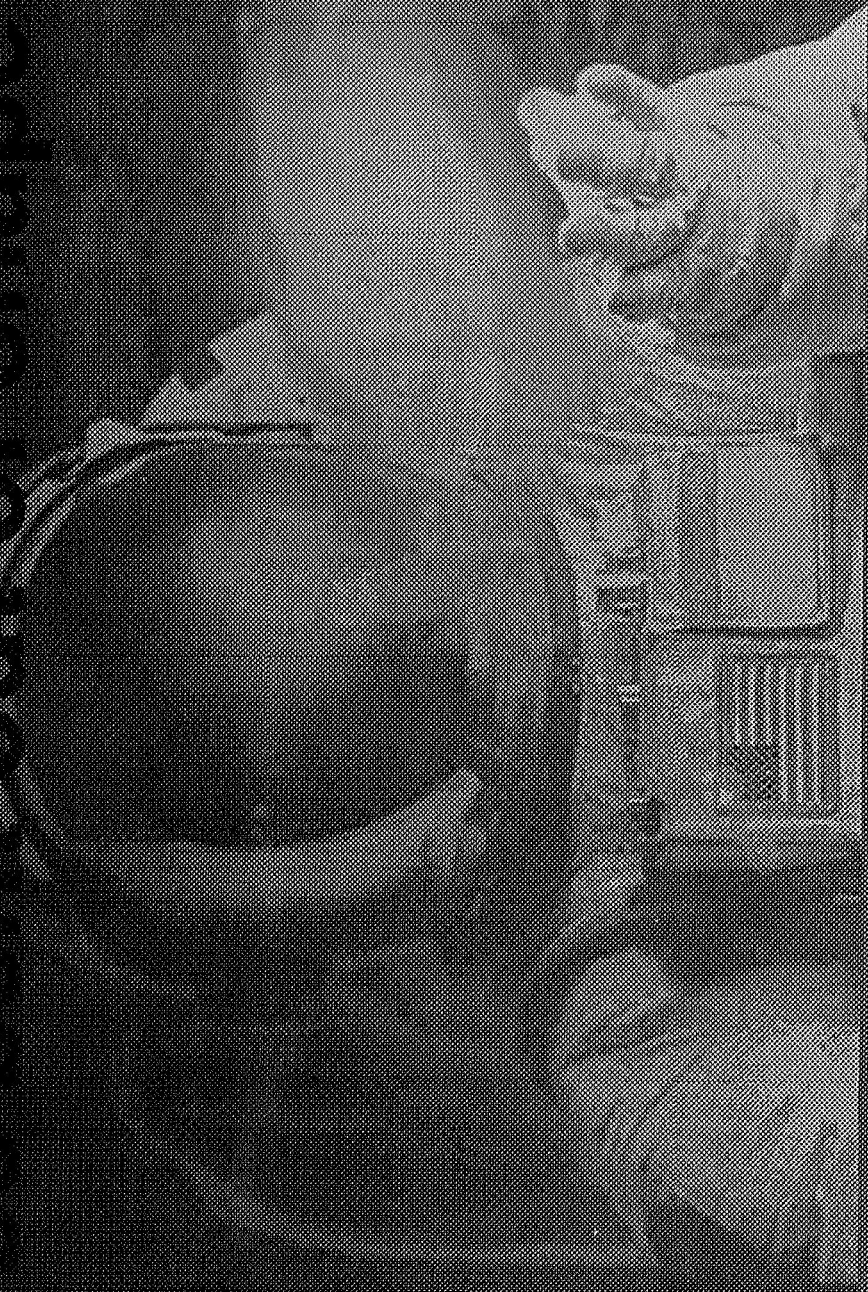
RFID

Nanocodes™



*Solutions for
Auto ID Work Together
Transparent to IT System*

excuse for they shall
not be bent out of shape



Thank You for the Hospitality

